GEOCHEMICAL DISCRIMINATION OF THE PERALUMINOUS DEVONIAN-CARBONIFEROUS GRANITOIDS OF NOVA SCOTIA AND MOROCCO

BY

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ABSTRACT

The peraluminous granites of Nova Scotia and Morocco are compared to assess the viability of the Moroccan Model that postulates that the Meguma Zone (a suspect terrane of the northern Appalachians) was derived from north-western Africa. In addition, the relationship between the so-called northern and southern plutons of Nova Scotia is examined. A geochemical database of over 1300 analyses of peraluminous granites from Nova Scotia, Morocco, Iberia (another potential source area) and, Australia (a presumably unrelated belt) was carefully compiled for this study. The geochemical data were examined using both a traditional approach and discriminant function analysis (a multivariate statistical technique).

Results obtained by traditional methods of comparison indicate that the northern and southern plutons of Nova Scotia, although different, could not be clearly separated into two groups. In addition, the granites of Nova Scotia and Morocco appear indistinguishable.

Various statistical models demonstrate the applicability of discriminant analysis to the geochemical compositional granitic data by succesfully analyzing bimodal and skewed populations, uneven sample groups, and compositional data.

Several statistical models compare the geochemical populations of northern and southern Nova Scotia; Nova Scotia and Morocco; Nova Scotia, Morocco, and Iberia and; the Atlantic and Australian granites. Results indicate that the northern and southern plutons of Nova Scotia appear geochemically distinct; the Nova Scotia and Morocco populations show some similarities; Nova Scotia, Morocco (Zaer pluton of the Central Massif) and Iberia are equally similar; and, the Atlantic and Australian granites are clearly distinct.

Comparison of discriminant function coefficients obtained on the local (north-south Nova Scotia), regional (Nova Scotia-Morocco and Nova Scotia-Morocco-Iberia) and orogen-scale (Atlantic and Australian granites) show that at each scale of reference a characteristic suite of elements can be defined as good discriminators.

Results obtained thoughout this study indicate that discriminant function analysis is more useful and revealing than traditional methods of comparison. Although no clear evidence was found to confirm the Moroccan Model, results suggest that Morocco cannot be excluded as a potential source area for the Meguma Terrane.

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Je dédie cet ouvrage à ma famille.

CHAPTER 1

INTRODUCTION AND GEOLOGICAL SETTING

1.1 Introduction

Granites form an integral part of orogenic belts and may be components of suspect terranes. A suspect terrane is an area of unknown origin that has a geological history distinct from, and unrelated to, neighbouring terranes. As such, the study of a granite population, when present in a suspect terrane, can be useful in determining probable provenance. In order to make correlations between igneous rocks of a suspect terrane and those of a possible source region using geochemical populations, it is necessary to distinguish between locally induced chemical variations, and those chemical characteristics that are indigenous to the region of study. Given the complexity of granitic systems, and the difficulties encountered in isolating the effects of the many different processes that affect granitic rocks, the simple traditional approach which examines the interrelationships among only a few components may not be satisfactory. Instead, a multicomponent approach is suggested as a more appropriate way of solving this complex problem.

In this study, the granitic rocks of the Meguma Zone, an apparently suspect terrane of the northern Appalachians, are examined and compared with rocks of similar composition and age from both Morocco (NW Africa), and Iberia. Australian rocks from a presumably unrelated orogenic belt, but of similar composition and age are considered to provide an independent datum for comparison.

The results of this investigation should provide further insight into the origin of the Meguma Terrane. In addition, some understanding may be gained about the variation of granites from a local scale to the orogenic scale.

1.2 The Meguma Zone

The Meguma Zone, located in the southern part of Nova Scotia, consists mainly of Cambro-Ordovician clastic metasediments intruded by Devono-Carboniferous peraluminous granitoid rocks, and overlain by a late Devonian to Carboniferous sequence of red beds, clastic sediments, carbonates and evaporites.

The stratigraphy of the Meguma Terrane is summarized in Figure 1.1, where the lithologies are grouped with reference to the Acadian orogenic event. Pre-orogenic lithologies include the Goldenville, Halifax, White Rock, Kentville and Torbrook Formations, whereas the Horton Group, Windsor Group and Supra-Windsor Carboniferous Units post-date the Acadian Orogeny.

The Cambro-Ordovician Meguma Group is the oldest exposed sequence in the region and includes the Goldenville (sandy high density turbidites) and Halifax (silty low density turbidites) Formations. This succession, approximately 18 Km thick, has been interpreted as a proximal and distal turbidite sequence (Schenk 1970, 1973; Schenk and Lane 1982). Scarce fossil assemblages indicate a Tremadocian age for the upper part of the Meguma Group (Schenk, 1983). Radiometric ages on detrital muscovite grains from the Goldenville Formation, yield Tremadocian to Arenigian ages (Poole, 1971). Based on lithological and paleocurrent studies, Schenk (1970) suggested that the sediments were derived from a landmass located to the present southeast. Schenk (1983) further suggested a low-lying, deeply eroded source area of predominantly granodioritic composition and probably Precambrian in age. Clarke and Halliday (1985) using Sm/Nd isotopes were able to determine a mean crustal residence time of $T_{DM} = 1773 \pm 95$ Ma for the Meguma Group sediments. Krogh and Keppie (1986) using the U-Pb isotopic technique on detrital zircons from the greenschist facies of the Goldenville Formation were able to identify two different source ages, one of 600 Ma and the other of 2000-2700 Ma. These provinces correspond to the Hoggar Area of West Africa.

Maritime Disturbance (=Hercynian = Variscan orogenies) 300-320 Ma, late in Carboniferous (Westphalian) = collision of North America with Africa.				
Carboniferous	Late	Pictou Group	Sandstone & siltstone	Post-Acadian orogeny lithostratigraphy
Carboniferous	Late	Canso Group	Siltstone & sandstone	
Carboniferous	Early	Windsor Group	Limestone, evaporites,siltstones,evaportites	
Carboniferous / Devonian	Early	Horton Group	Sandstone, siltstone, carbonate & conglomerate	
Acadian Orogeny (Maximum age, 415-400 Ma) (385-405 Ma in greenshist facies.) Intrusion of peraluminous granites 386-360 Ma Northern and Southern plutons.				
Devonian		Torbrook Fm.	Siltstone, shale, quartzite, iron formation	Pre-Acadian orogeny lithostratigraphy
Silurian		Kentville Fm.	Black shale, Diamictite & volcanics (felsite)	
Silurian		White Rock Fm.	Quartzite, Mafic & felsic volcanics pelite, slate	
Ordovician		Halifax Formation	Slate & interbedded siltstone, quartz wacke	
Cambrian		Goldenville Formation ????????	Quartz wacke, conglomerate, slate, argillite, siltstone ????????????????????????????	

Figure 1.1. General stratigraphy of the Meguma Terrane. See text for source references.

The White Rock Formation (270 m), conformably overlies the Meguma Group and is mainly composed of quartzites, siltstones and minor felsic-mafic volcanics. It is considered to be a paralic sequence with volcanics (Schenk, 1983). Fossils in the White Rock Formation suggest an age range from Late Ordovician (post Caradocian) to Devonian (Lane, 1975, 1979).

The Kentville Formation, which conformably overlies the White Rock Formation, consists of black graptolitic slates, diamictites and felsites (Schenk, 1983). It has been interpreted as a neritic sequence with a thickness of approximately 1700 m. A late Silurian (Ludlovian) age is assigned to the Kentville Formation (Taylor, 1969).

The Torbrook Formation, a 1500 m thick sequence of quartzites, siltstones and shales, are the youngest pre-orogenic rocks in the Meguma Zone. This formation is an Early Devonian (Gedinnian to Emsian) (Jensen, 1976) inner shelf to estuarine sequence.

The late Devonian Acadian orogeny resulted in the folding, metamorphism and granitization of the pre-orogenic lithologies. Elias (1987) placed the minimum age of the Acadian orogeny at approximately 390 Ma. Structural studies carried out by various authors (Fyson, 1966; Poole, 1967; Taylor, 1967; Taylor, 1969; Keppie, 1977; Keppie, 1982; Keppie, 1984) have revealed a complex deformational history for these rocks. The main phase of deformation resulted in the formation of open to isoclinal folds, generally trending SW-NE.

Several episodes of metamorphism have been identified by Muecke (1984). Two high-grade metamorphic zones have been identified by Keppie and Muecke (1979) and Muecke (1984). The first high, located in the southwestern corner of the terrane, forms a concentric pattern interpreted by Muecke (1984) as a broad thermal doming event formed prior to granite emplacement. The second high grade zone forms a linear belt subparallel to the Glooscap shear zone and seems to be controlled by granite generation (Muecke, 1984). Based on observed metamorphic assemblages a low to medium pressure and high temperature regime is inferred, characteristic of Pyreneean-type metamorphic belts (Clarke et al., 1980; Muecke, 1984).

Peraluminous granites intrude the pre-orogenic lithologies. The South Mountain batholith and the northern satellite plutons were emplaced during the middle to late Devonian (372-361 Ma) (Clarke and Halliday, 1985; Reynolds et al., 1981). ^{40}Ar-^{39}Ar dating of the Meguma granites by Elias (1987) revealed a complex thermal history for the so-called southern satellite plutons. In a study of these results Reynolds et al., 1987 suggested that even though the argon dates on the southern plutons span a wider range of time they were generally emplaced at the same time as the northern plutons. The younger ages obtained for the southern plutons are attributed to a resetting event resulting from a Hercynian (= Variscan) tectono-thermal event around 300-320 Ma. A second reheating event of lesser impact affecting the southern plutons occurred around 220-230 Ma, and is believed to be related to the initial rifting of the Atlantic (Reynolds et al., 1987). The field relations of the Meguma granites are discussed in Chapter 2.

Upper Devonian to Permian red continental sediments were deposited unconformably upon the orogen. The Windsor Group limestones, evaporites and clastics were deposited in local marine basins which developed on the Meguma platform in the late Mississipian time (Poole, 1967; Schenk, 1978). Deformation which occurred late in the Carboniferous, is known as the Maritime Disturbance, and as also been referred to as the Hercynian deformation (Poole, 1967).

Insight into the place of origin of the Meguma suspect terrane has been sought by many authors (Schenk, 1970, 1971, 1983; Hollard and Schaer 1973; Clarke and Halliday, 1985; Krogh and Keppie, 1986). As a result of these investigations which have centered around the Meguma Group metasediments, various potential source areas have been suggested, including: western Europe, northwestrn Africa, Colombia, and western south America. This study provides further insight into the origin of the Meguma Zone by comparing its peraluminous granites with rocks of similar composition from two of its postulated source area, Morocco (NW Africa) and Iberia. Before beginning the study of the granitic rocks the general stratigraphy of Morocco will be given below.

1.3 General Moroccan Geology

In contrast to the Meguma Zone, Moroccan geology is complex and varied, and spans a wider range of time (oldest continental crust 3 Ga, Michard, 1976 p. 315). A number of orogenic events have affected Moroccan rocks throughout its history (Table 1.1). Generally the geology of Morocco is discussed in reference to structural domains defined by Michard (1976).

Several structural domains may be defined depending on the scale of reference (Table 1.2). Peraluminous granites in Morocco occur within Paleozoic massifs of the Meseta and Atlas domains (Figure 1.2). The general stratigraphy of these massifs is considered below.

1.3.1 Stratigraphy of Moroccan Paleozoic Massifs

The stratigraphy of the Jebilet, Rehamna and Central massifs of the Meseta domain as well as the Atlas domain is presented in this section. Only the general characteristics are given as detailed consideration of the Moroccan stratigraphy is beyond the scope of this thesis. The stratigraphy of each area is summarized and presented separately because many of the stratigraphic relationships within and between the massifs are unclear, and no succinct stratigraphic column exists for the Moroccan rocks. This general approach will also allow the reader to appreciate how variable the stratigraphy can be within and between the massifs.

In many instances the ages of the host rocks have been assigned on the bases of lithology rather than actual dating. For example, a host flysch will be given a Visean age simply because Visean flysch appear

Table 1.1. Moroccan orogenic cycles as reported by Michard, 1976 (simplified).

OROGENIC CYCLE	AGE	
Alpine	Triassic to Pliocene	(180-1 Ma)
Caledono-Hercynian	Infracambrian to Permian	(530?-250 Ma)
Pan-African	Eocambrian (?)	(1100?-550?Ma)
Eburnean	Ancient Precambrian	(1800-2000 Ma)?
Archean	Relic in ancient Precambrian	(3000? Ma)

Table 1.2. Main stuctural domains of Morocco as defined by Michard, 1976. Based on the Alpine Orogeny.

<table>
<tr><td>Mediterannean Morocco</td><td colspan="3">Rif Domain</td><td>Part of the broader Alpine orogenic belt extending north with the Betique mountain chain and east with the Tellian and Kabyle mountain chains.</td></tr>
<tr><td rowspan="5">African Morocco</td><td rowspan="3">Middle Morocco (Atlasic domain)</td><td colspan="2">Meseta</td><td rowspan="3">The rocks of the Meseta and Atlas domains have been affected by various orogenic events. Caledonian movements are best defined in the occidental part of the terrane. The Hercynian orogeny affected rocks with varied intensity depending on the region with folding, faulting and granitization. The Alpine orogeny caused subsidence in the region, and produced faulting in the basement rocks and folding of the cover rocks during the Jurassic period.</td></tr>
<tr><td rowspan="2">Atlas</td><td>Middle Atlas</td></tr>
<tr><td>High Atlas</td></tr>
<tr><td colspan="3">Anti-Atlas Domain</td><td>The Hercynian deformation affected primary rocks with varied intensity with some strata remaining sub-tabular, while others were severly folded showing vertical schistosity and some thrusting.</td></tr>
<tr><td colspan="3">Zones of Subsidence</td><td>Subsidence occurred during the later phases of the Alpine orogeny (upper Miocene). Generally separating the mountain chains (Rif and Atlas) from platforms (Meseta and Anti-Atlas), some depressions are intramountain (e.g. Haute Moulouya, Atlas domain).</td></tr>
</table>

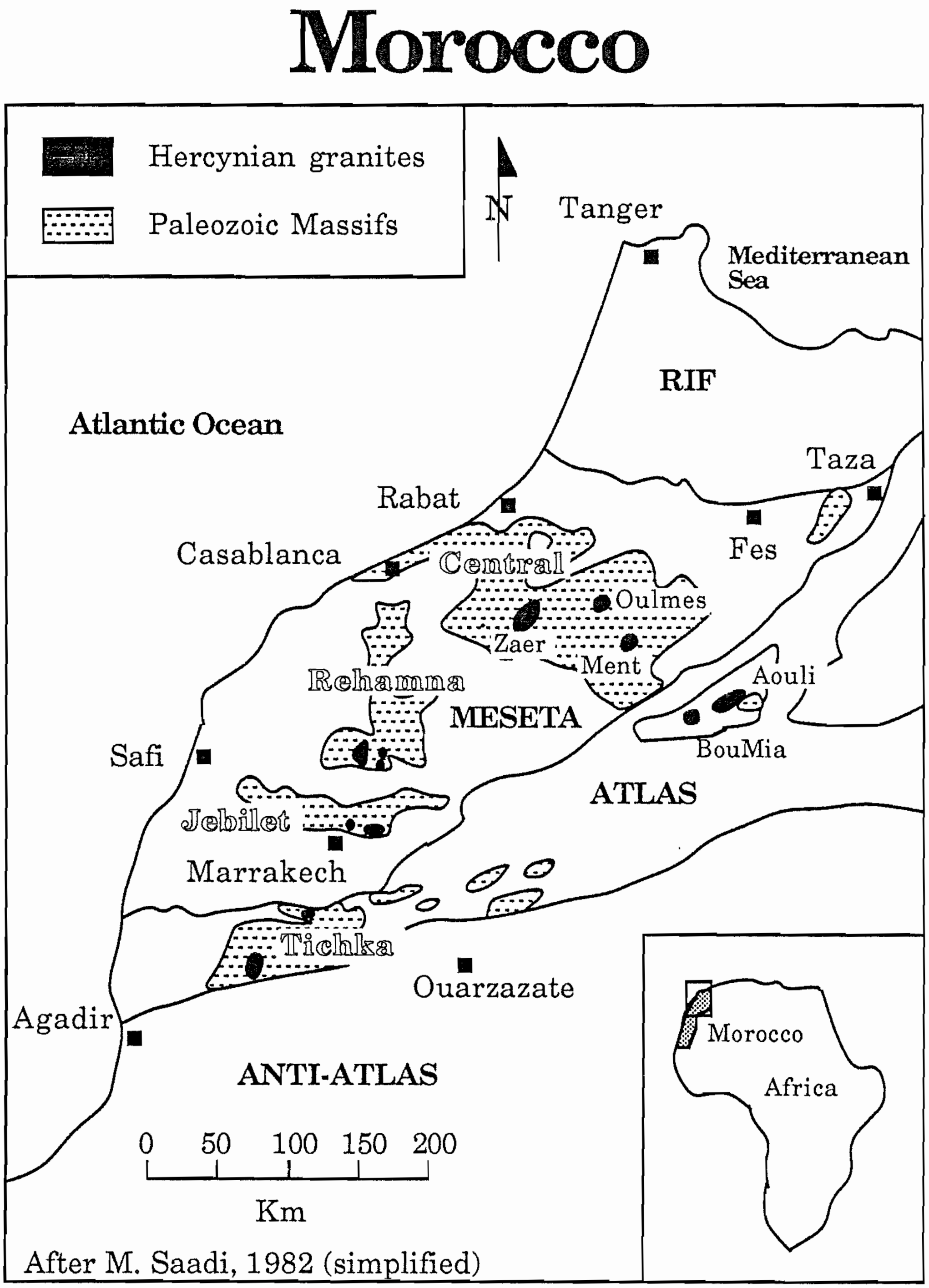


Figure 1.2. Geological map of Morocco.

to be most common. Therefore the following Figures should be considered with caution.

The Jebilet Massif (Figure 1.2) of the southern Meseta is located approximately 7 km north of the city of Marrakech. Three main structural units have been defined within the Jebilet Massif; they are 1) the western Jebilet, 2) the Bou-Gader and Skhirat units and 3) central and eastern Jebilet (Michard, 1976; Huvelin, 1977; Hollard et al., 1977; Pique et al. 1983). They are characterized by the nature of the terrain and style of Hercynian deformation. The stratigraphy of each unit is given in Figure 1.3.

The Rehamna Massif (Figure 1.2), located approximately half way between Casablanca and Marrakech, offers many lithological similarities with the Jebilet Massif. A summary of the stratigraphy of four structural domains as defined by Michard (1982) is presented in Figure 1.4. They are the Mechra-Ben-Abbou (northern Rehamna), the western, the eastern and the central Rehamna domains (Michard, 1976, 1982; Hollard et al., 1982; Destombes et al., 1982).

The stratigraphy of the Central massif of the northern Moroccan Meseta is given in Figure 1.5. A summary stratigraphic column is also given for Paleozoic rocks of the Atlas domain from the Tichka Massif (Figure 1.5).

The Paleozoic history of Morocco can be summarized as follows (Michard, 1976, 1978, 1982; Huvelin, 1977; Destombes J. et al., 1985; Schenk, in prep.). An Infracambrian transgression over the western African platform resulted in the deposition of sedimentary carbonate rocks (Anti-Atlas). Thick siliciclastic sequences were deposited (from the S.E.) throughout Morocco in the Middle Cambrian and were supplied continuously thru the Lower Cambrian from the NW Craton. Also prominent throughout Morocco during the Middle Cambrian are thick complexes of trachyandesites, basalts, andesites, breccias and tuffites. A generalized regression occurred during the middle to late

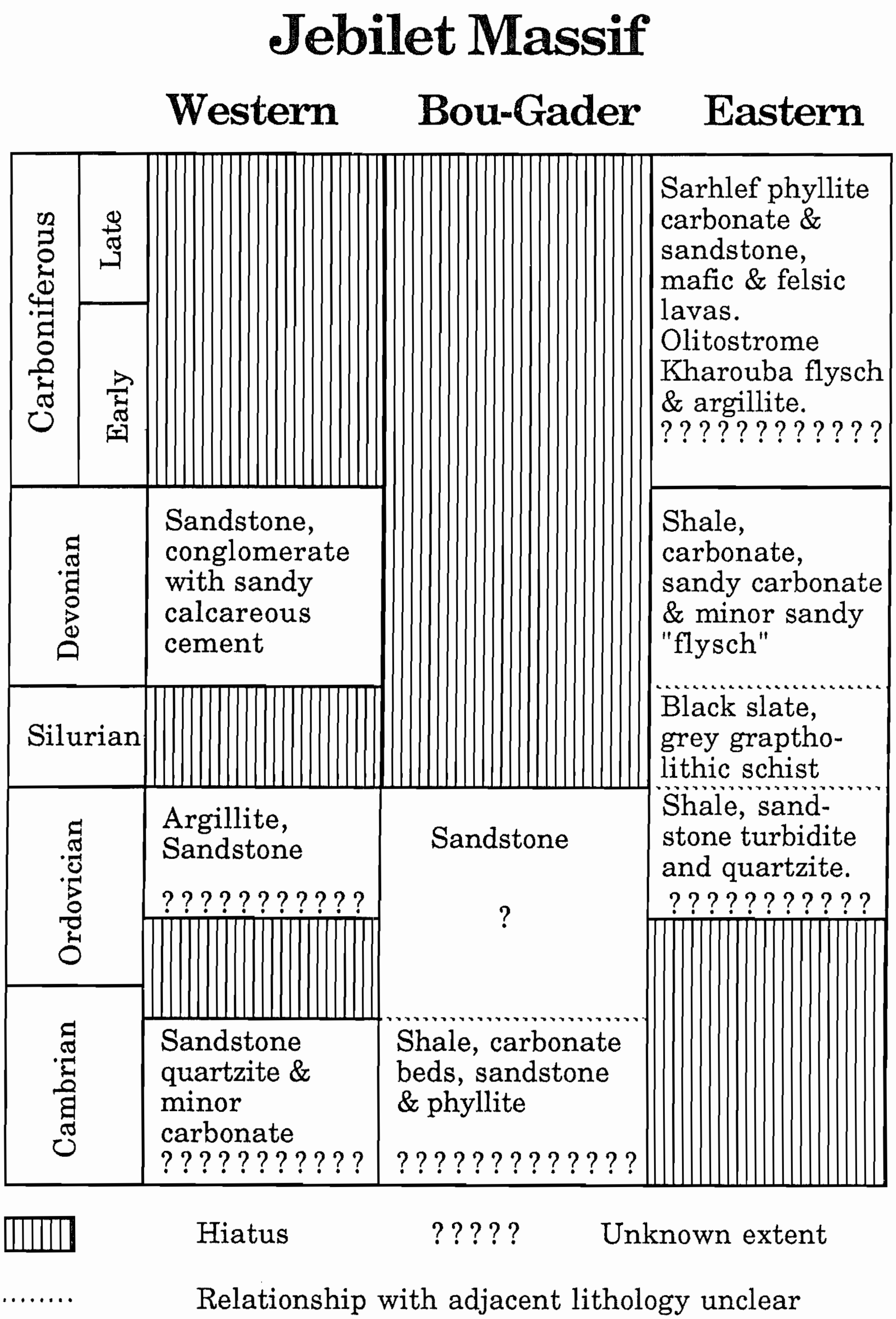


Figure 1.3. Schematic representation of the Cambrian to Carboniferous stratigraphy of the Jebilet Massif, Morocco. See text for source references.

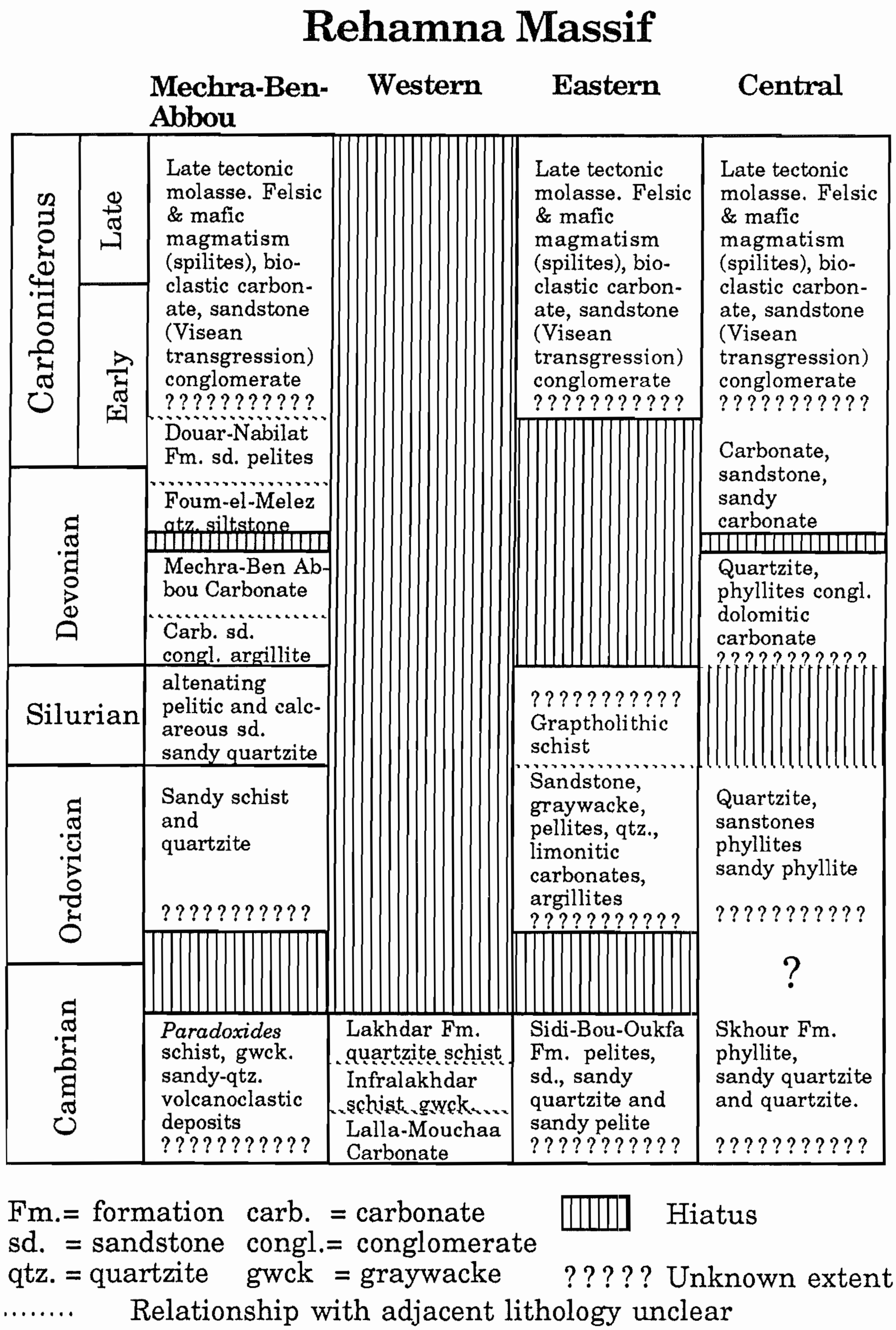


Figure 1.4. Schematic representation of the Cambrian to Carboniferous stratigraphy of the Rehamna Massif, Morocco. See text for source references.

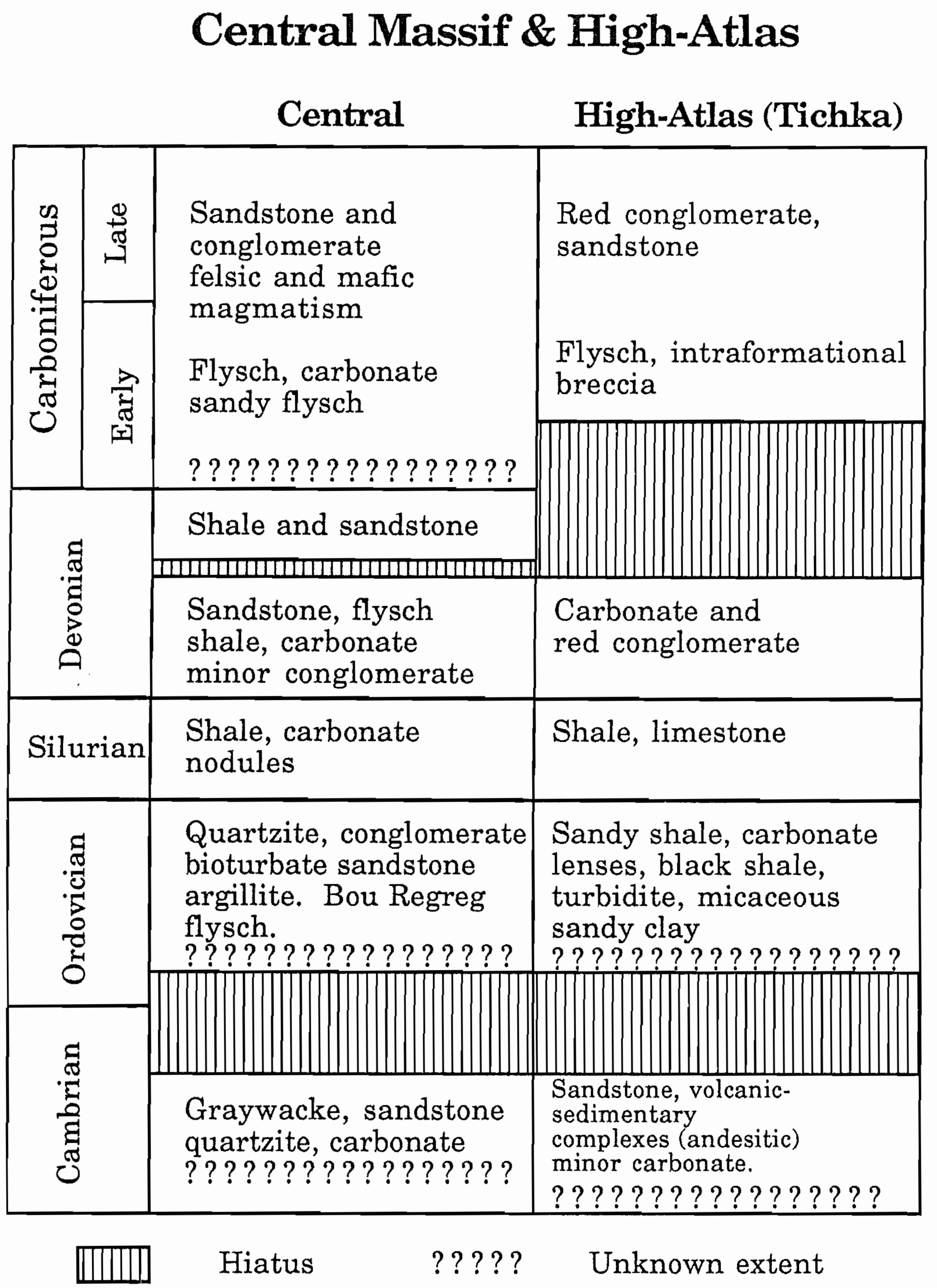


Figure 1.5. Schematic representation of the Cambrian to Carboniferous stratigraphy of the Central Massif and High Atlas, Morocco. See text for source references.

Cambrian, earlier in the Anti-Atlas region and later in central Morocco, terminating with the deposition of sandstones and minor volcanic facies throughout Morocco (with pyroclastics in the western high Atlas, Jebilet and Rehamna).

No upper Cambrian or early Ordovician (Tremadoc) rocks have been identified in northern and central Morocco (Tremadoc deposits occur within the Anti-Atlas), and this time is considered an epeirogenic period during which pre-existing lithologies may have been weakly folded.

A transgression occurred early in the Ordovician (Arenig). Little is known in detail about the Ordovician north of the Anti-Atlas, however, it generally consists of predominantly argillaceous sediments with minor amounts of sandstones. A continental influence appears several times during the Ordovician and is suspected to represent a Caledonian event in western Morocco during this period. The Ordovician ended with a glaciation from the SE resulting in the deposition of glaciomarine sediments during the Late Ashgill.

A transgression occurred early in the Silurian which peaked during the middle to upper Llandoverian. Platy sandstones, graptolitic shales and siltstones were deposited in the Anti-Atlas region and dark graptolitic shales in northern Morocco (Hollard, 1970). Thin basaltic flows are intercalated in western Morocco with the lower Silurian series (Cornee et al., 1985).

Lower to Middle Devonian epicontinental, sometimes intertidal, and even subaerial deposits, occur throughout Morocco. Frasnian rocks are absent in most places. Local deformation in the Late Devonian indicates the beginning of the Hercynian deformation.

Upper Visean rocks discordantly overlie the previous discussed lithologies. A Late Visean transgression is evident throughout the area. Felsic and mafic magmatism are also associated with these deposits.

Syn-, but mostly, post- tectonic peraluminous granites intrude the "pre-orogenic" lithologies discussed above, and are found within the Meseta and Atlas Paleozoic massifs. These granites are the main thrust of this thesis and are considered in detail in Chapter 2.

1.4 Comparing the Nova Scotian and Moroccan Stratigraphy

Based on the lithologies of the different massifs and work done by Schenk (in prep.), a summary table of the stratigraphy of Morocco is compared with the Meguma Terrane in order to demonstrate the lithologic similarities between these areas, and provides justification for comparing Morocco with the Meguma Terrane (Figure 1.6).

1.5 Purpose of This Study

The objectives of this thesis are:

1) to assess the significance of the chemical variations observed within plutons of the Meguma Terrane;

2) to investigate the geochemical characteristics of the Moroccan granites sampled during this study, as well as those studied by previous workers, to characterize the geochemical nature of the Moroccan granites;

3) to evaluate the applicability of multicomponent analysis (discriminant function analysis) to granitic rocks and, in particular, to assess the reliability of the application of such analysis when performed on compositional data (geochemical data);

4) to examine the relationship between the Nova Scotian, Moroccan and Iberian granites using discriminant function analysis, to assess the

Nova Scotia - Morocco

Period	Epoch	Nova Scotia	Morocco
Carboniferous	Late	Sandstone siltstone.	Sandstone,
Carboniferous	Early	Limestone, evaporites.	Carbonate,
Carboniferous / Devonian	Early	Sandstone, siltstone, carbonate, conglomerate.	Mafic and felsic magmatism, olistostrome, and conglomerate. Carbonate, siltstone.
Devonian		Hiatus	Hiatus
Devonian		Sandstone, shale and quartzite.	Sandstone, shale, carbonate, and conglomerate.
Silurian		Black shale Sandstone, mafic and felsic volcanism.	Black shale (limestone in High-Atlas)
Ordovician		Laminated shale diamictite Shale, siltstone. Turbidites from S.E.	Laminated shale diamictite Shale, siltstone, limestone.
Ordovician / Cambrian			Hiatus
Cambrian		Shale. Sandstone, siltstone, congl., slate, argillite, turbidites from S.E. ??????????????????	Sandstone, quartzite shelf from S.E. Carbonates, volcano-clastic deposits. ?????????????????

Hiatus (hatched box) ????? Unknown extent

Figure 1.6. Schematic comparison of the Cambrian to Carboniferous stratigraphy of Nova Scotia and Morocco. See text for source references.

degree of similarity between these Hercynian rocks. These rocks are in turn compared with Australian rocks presumably of an unrelated orogenic belt but of similar composition and age, providing an independent datum by which to assess the validity of observed variations;

5) to compare and discuss results obtained using both the traditional geochemical and the multicomponent approaches, in order to evaluate the degree of information obtained by each method;

6) to discuss and evaluate the viability of the "Moroccan model" in light of the results obtained during this study.

CHAPTER 2

FIELD RELATIONS, PETROGRAPHY AND GEOCHRONOLOGY

2.1 Introduction

In this Chapter the general field relations, petrography and, geochronology of peraluminous granites of Nova Scotia and Morocco are discussed in order to familiarize the reader with the granitic rocks from these two areas. A broad regional approach is adopted compatible with the approach to assess variation only on a regional scale.

2.2 Nova Scotian Granites

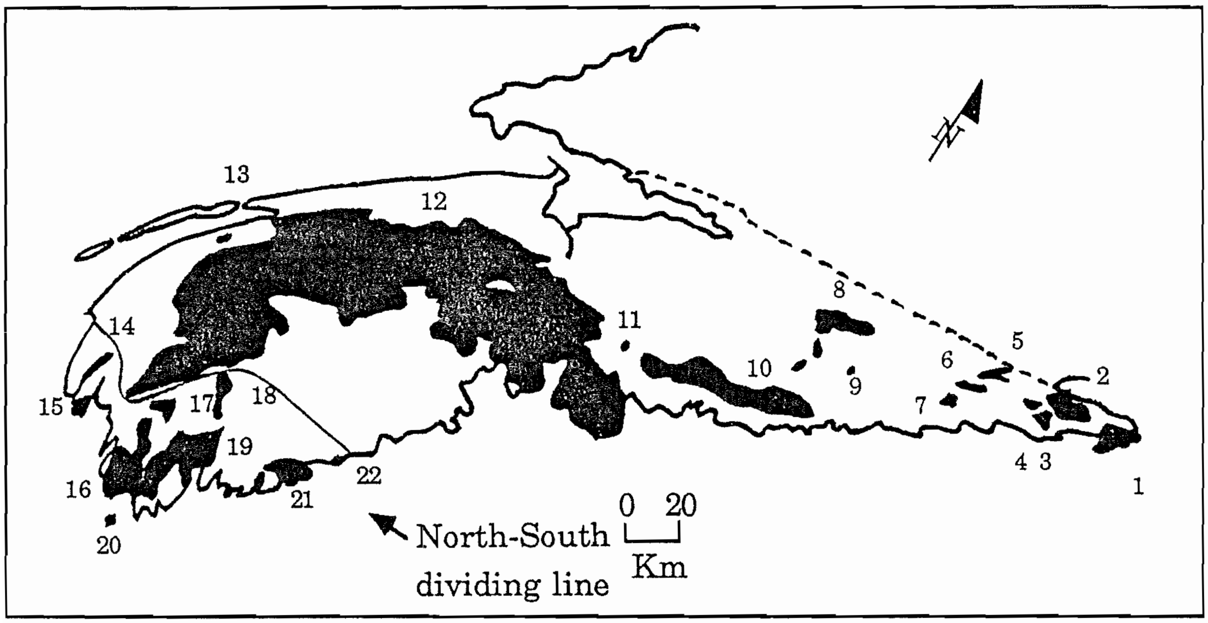
2.2.1 Introduction

Differences in composition, age and, emplacement between the northern and southern peraluminous plutons of the Meguma Zone of Nova Scotia have been recognized by workers in the past. A selected division based on some of their observations was drawn between both areas and is shown in Figure 2.1. The general characteristics of each area is given below. Emphasis has been placed on their differences.

2.2.2 The Northern Plutons

The northern plutons include the South Mountain batholith (McKenzie, 1974; McKenzie and Clarke, 1975; Clarke and Muecke, 1987; Richardson, in prep.), the Musquodoboit pluton (MacDonald, 1981; MacDonald and Clarke, 1985), the Liscomb pluton (Cameron, 1985), the Sherbrooke pluton (Smith et al., 1987, Alizay, 1981), the Bull Ridge pluton (Bernadette, 198?), the Ellison Lake pluton (Allan, 198?), the Kinsac pluton (Coolen, 1974), the Mulgrave pluton (Dwyer, 1975), the Halfway Cove and Queensport plutons (Ham, in prep.), the Sangster Lake and Larry's River plutons (O'Reilly, in prep.) and the Canso pluton (Hill, 1986). Generally all of these plutons range in composition from

Nova Scotia



Northern Granites

1 White Haven
2 Queensport/ Halfway cove
3 Larry's River
4 Sangster Lake
5 Forest Hill
6 Bull Ridge
7 Sherbrooke
8 Liscomb
9 Mulgrave
10 Musquodoboit
11 Kinsac
12 South Mountain
13 Ellison Lake

Southern Granites

14 Brenton
15 Wedgeport
16 Barrington Passage
17 Bald Mountain
18 Beach Hill
19 Shelburne
20 Lyons Bay/ Seal Island/
Western Granite
21 Port Mouton
22 Eastern Head/
Moose Point

Figure 2.1. Geological map of the Meguma Terrane.

granodiorite, to monzogranite and may include some late stage leucomonzogranites. The only exception, the Canso pluton, is reported to contain some tonalites (Hill, 1986).

2.2.3 The Southern Plutons

The southern plutons include the Barrington Passage pluton (Smith, 1979; Rogers, 1985), the Lyons Bay, Seal Island and Western Granite plutons (Rogers, 1985), the Wedgeport pluton (Reynolds et al. 1981; Keppie et al., 1983; Wolfson, 1983; Chatterjee et al., 1985), the Shelburne pluton (Rogers, 1985), the Brenton pluton (O'Reilly, 1976; Clarke et al., 1979), the Bald Mountain pluton (Rogers, 1985), the Moose Point pluton (Weagle, 1983) and the Port Mouton pluton (Alburquerque, 1977; Douma, 1988).

In contrast to the northern plutons, compositions within the southern plutons are more varied, showing a composition range from diorite, norite, hornblende and biotite tonalites, trondhjemites, granodiorites, monzogranites and, leucomonzogranites. In addition, Douma (1988) has reported lamprophyres in the Port Mounton pluton.

2.2.4 Geochronology of the Nova Scotian Granites

Average $^{40}Ar/^{39}Ar$ radiometric ages within the northern plutons range from 366.7 $\pm$ 11 Ma for the SMB, to 365.5 $\pm$ 4.3 Ma for the remaining northern plutons (Reynolds et al., 1981). These ages contrasts markedly with 337 $\pm$ 16 Ma (Elias, 1987) reported for the southern plutons, with some older ages obtained within the Bald Mountain and Barrington Passage plutons (370-386 Ma). As discussed in Chapter 1 these younger ages are believed to be the result of a tectono-thermal event within the area around 300-320 Ma (Reynolds et al., 1987). Such younger ages are not exclusive to the southern plutons, mineralization within the northern plutons, particularly the SMB, have been reported at around 330 Ma (e.g. East Kemptville, SMB). In addition, distinctly younger ages of about 280 Ma are reported within other metasomatized and altered granites of the northern plutons (Reynolds et al., 1981; Zentilli and Reynolds, 1985), as well as the southern plutons (Elias, 1987).

In summary, the intrusions of granites throughout the Meguma Zone occurred between 386-360 Ma (Elias, 1987). Evidence suggests that the northern plutons were generally unaffected by the Hercynian event except for some localized areas; however the southern plutons were pervasively affected by this tectono-thermal event. This suggests a difference in the Hercynian tectono-thermal history of both areas.

2.2.5 Emplacement of the Nova Scotian Granite

The regional metamorphic grade of the northern country rocks is predominantly of the greenshist facies. In contrast the metamorphic grade is observed to increase southward, reaching an amphibolite facies near the Shelburne pluton (Muecke, 1984). This suggests that the southern plutons may have been emplaced at greater depths than the northern plutons. Some southern plutons (Brenton, Barrington Passage and Shelburne) show pre- and syn- tectonic emplacement as opposed to the northern plutons which are reported to be post-tectonic.

2.3 Moroccan Granites

2.3.1 The Jebilet Massif

2.3.1.1 Introduction

Peraluminous granites occur within the central part of the Jebilet massif of Morocco (Figure 1.2) and intrude rocks folded during upper Visean (possibly Namurian?) time. They are the Oulad Ouaslam batholith, Tabouchennt-Bamega pluton, Bramram greisen and, Sidi Bou Othmane pegmatites.

2.3.1.2 Oulad Ouaslam Batholith

The Oulad Ouaslam batholith (OOB), the most extensive of all of the Jebilet granites, crops out over an area of approximately 300 Km^2 and is located north of Marrakech and east of the main highway leading to Casablanca. Forty-eight samples collected from the Oulad Ouaslam batholith were slabbed, stained with sodium cobaltinitrite, and point-counted using a binocular microscope (details are presented in Appendix A). Sample locations are shown in Figure 2.2. Individual results for each specimen are presented in Table 2.2 and classified using the terminology of Streckeisen (1976) (Figure 2.3).

It should be pointed out that the sample population was intentionally biased by selecting those specimens which were not associated with mineralisation or with any form of extensive alteration. These "secondary" processess were excluded to ensure the comparability of the populations. Given time constraints and the considerable area covered, sampling was not carried out in any detail. Instead, the objective of the sampling was to obtain a good regional coverage of each pluton.

Compositions within the batholith range from granodiorite to monzogranite, and plot as one coherent population on a Streckeisen diagram (Figure 2.3), indicating that individual units can not be defined within the batholith based on modal mineralogical proportions. Mrini (1985) reported a classification scheme determined by Rose (in prep) which he suggested could be applied to all of the granites within the Jebilet Massif. This scheme essentially divides the Jebilet granites into two main rock types; the granodiorites (or calc-alkaline biotite granites) and leucogranites (or two-mica granites).

Granodiorite (referred to as monzogranites and granodiorites using the terminology of Streckeisen), is the dominant facies within the Jebilet granites. According to Mrini (1985) the granodiorites can be

Oulad Ouaslam Batholith

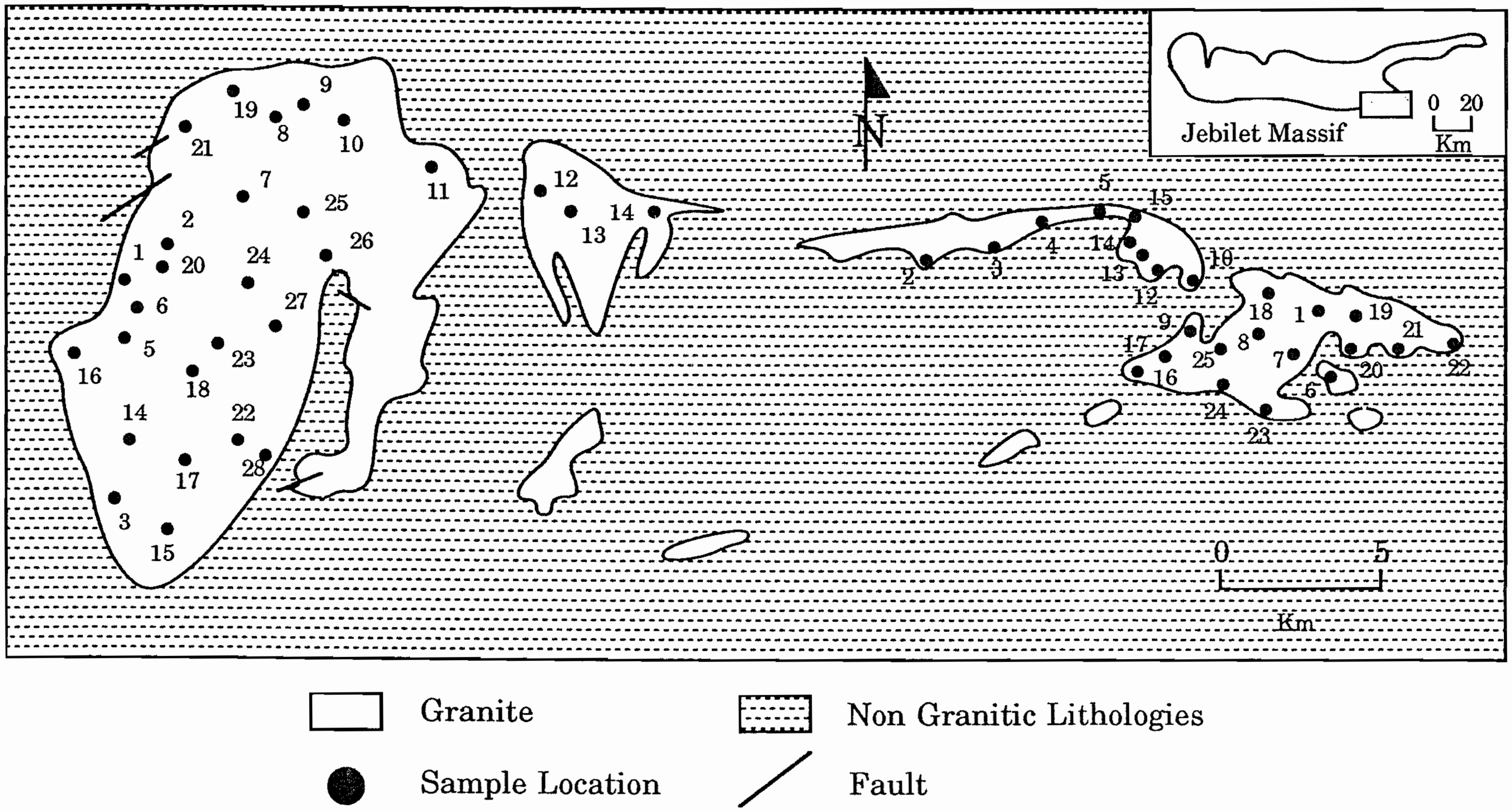


Figure 2.2. Location of samples collected from the Oulad Ouaslam batholith, Jebilet Massif. Note: The prefixes JBL and JUB are used to identify samples from the West and the East respectively.

Table 2.1. Modal analysis of samples from the Oulad Ouaslam batholith (Jebilet Massif). Based on stained slabs counting, 1000-2000 points. See Figure 2.3 for plot of QAP diagram.

SAMPLE	JBL1B	JBL2A	JBL3	JBL4	JBL6	JBL8	JBL9	JBL10
Quartz	30.3	32.4	32.1	29.8	37.8	33.1	22.6	27.4
Plagioclase	33.2	37.6	36.3	38.6	38.7	39.5	41.4	41.4
K-Feldspar	34.0	16.0	20.4	18.4	10.0	16.1	21.4	14.6
Biotite	1.3	9.2	7.2	10.3	10.9	10.3	13.5	13.3
Muscovite	1.3	4.7	4.0	2.9	2.7	1.0	1.1	3.3
Rock name	Mg	Gd	Mg	Gd	Gd	Gd	Gd	Gd

SAMPLE	JBL11	JBL12	JBL13	JBL14	JBL15	JBL17	JBL19	JBL21
Quartz	34.8	27.9	32.0	33.5	29.1	28.2	29.9	32.0
Plagioclase	36.7	39.8	33.2	39.1	34.4	34.3	41.3	35.0
K-Feldspar	20.9	20.4	27.2	15.3	31.9	23.2	15.0	14.0
Biotite	4.7	10.3	5.9	11.2	3.7	10.1	11.5	15.4
Muscovite	2.9	1.6	1.8	0.8	0.9	4.2	2.4	3.7
Rock name	Mg	Gd	Mg	Gd	Mg	Mg	Gd	Gd

SAMPLE	JBL22	JBL23	JBL24	JBL25	JBL26	JBL27	JBL28	JUB1
Quartz	27.8	28.5	30.2	28.6	30.4	28.6	28.0	24.1
Plagioclase	41.3	42.5	40.4	37.3	34.2	38.4	48.9	39.3
K-Feldspar	18.0	15.7	19.0	22.5	26.6	17.0	7.4	27.3
Biotite	11.8	11.0	8.0	11.2	6.4	12.7	13.9	8.2
Muscovite	1.1	2.3	2.5	0.3	2.4	3.4	1.8	1.1
Rock name	Gd	Gd	Gd	Mg	Mg	Gd	Gd	Mg

SAMPLE	JUB2	JUB3	JUB4	JUB5	JUB6	JUB7	JUB8	JUB9
Quartz	38.2	29.8	29.2	25.1	32.9	25.1	27.9	33.5
Plagioclase	29.6	38.3	35.9	40.3	44.1	42.6	39.0	36.4
K-Feldspar	18.4	20.1	19.9	18.4	17.8	26.4	22.6	19.5
Biotite	12.1	10.6	13.6	13.7	4.9	5.8	9.0	8.8
Muscovite	1.7	1.3	1.3	2.4	0.4	0.1	1.5	1.7
Rock name	Mg	Gd	Mg	Gd	Gd	Mg	Mg	Gd

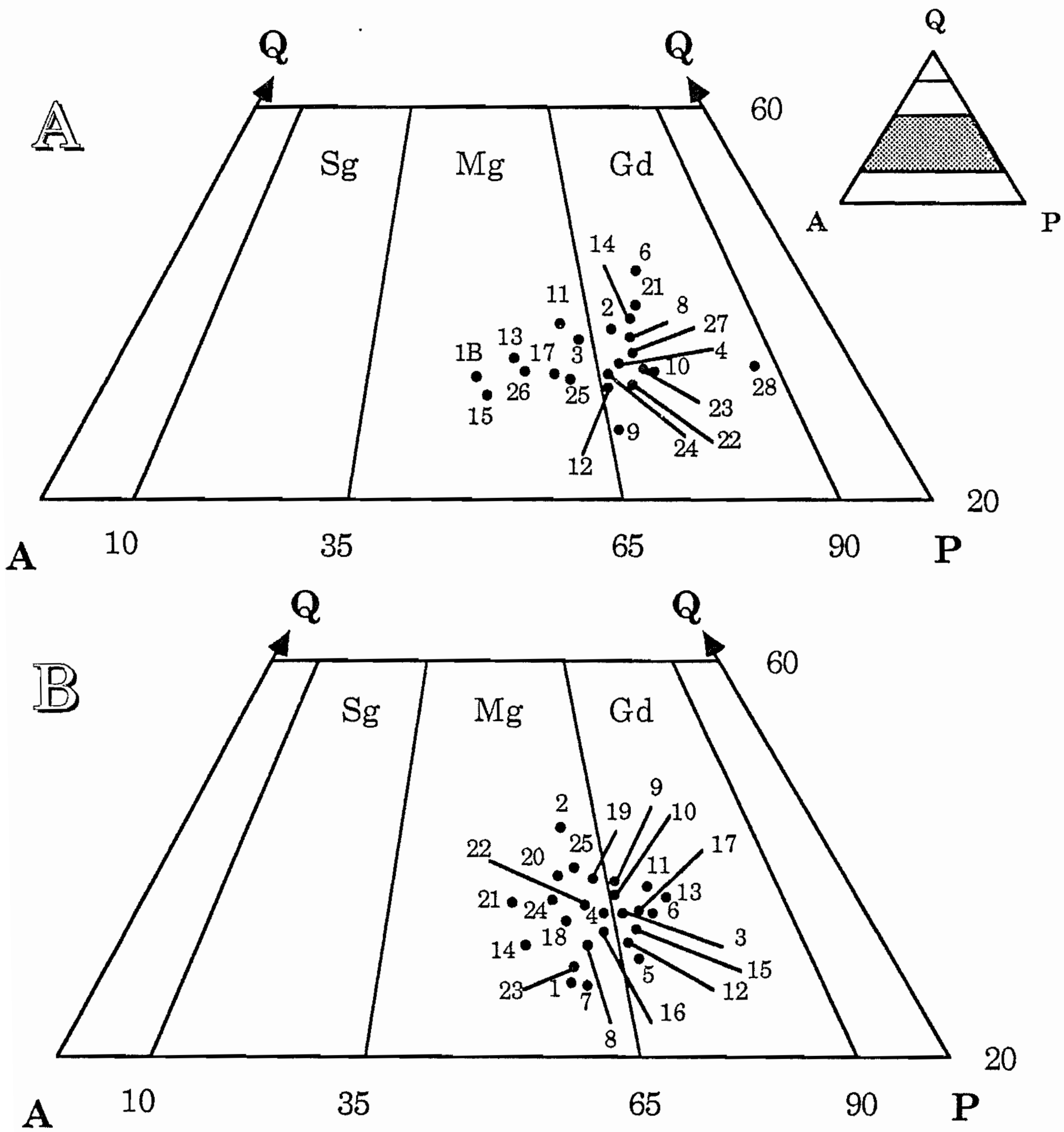
Mg = monzogranite Gd = granodiorite

Table 2.1 (cont.). Modal analysis of samples from the Oulad Ouaslam batholith (Jebilet Massif). Based on stained slabs counting, 1000-2000 points. See Figure 2.3 for plot of QAP diagram.

SAMPLE	JUB10	JUB11	JUB12	JUB13	JUB14	JUB15	JUB16	JUB17
Quartz	32.1	33.6	26.1	32.8	28.3	30.2	28.7	30.5
Plagioclase	36.9	40.5	45.5	40.2	33.2	43.7	37.2	41.5
K-Feldspar	19.3	15.6	21.7	14.8	27.9	20.0	20.5	19.3
Biotite	9.9	6.0	5.9	10.4	8.9	5.1	12.3	7.3
Muscovite	1.8	4.3	0.9	2.3	1.8	1.1	1.3	1.3
Rock name	Gd	Gd	Gd	Gd	Mg	Gd	Mg	Gd
SAMPLE	JUB18	JUB19	JUB20	JUB21	JUB22	JUB23	JUB24	JUB25
Quartz	31.2	33.5	36.1	32.8	31.7	26.3	33.7	36.7
Plagioclase	36.1	35.7	34.4	30.9	35.1	38.7	32.8	35.3
K-Feldspar	24.0	20.4	23.8	29.2	21.4	26.1	24.8	21.4
Biotite	7.5	9.4	4.2	5.5	10.0	7.8	6.7	5.3
Muscovite	1.2	1.0	1.6	1.6	1.8	1.1	2.0	1.3
Rock name	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg

Mg = monzogranite Gd = granodiorite

Oulad Ouaslam Batholith



Sg = syenogranite Mg = monzogranite Gd= granodiorite

Figure 2.3. QAP (Quartz- Alkali Feldspar- Plagioclase) plot of modal analysis from the Oulad Ouaslam batholith (Jebilet Massif, Morocco). (A) western part, (B) eastern part of the OOB. See Table 2.1 for modal analysis and Figure 2.2 for sample locations. Classification after Streckeisen, 1976.

further divided into two groups depending on whether or not cordierite is present in the assemblage.

The monzogranites and granodiorites are variable in grain size and contain quartz, phenocrysts of K-feldspar, plagioclase, and abundant biotite (5-15 %). The latter may be found as individual crystal or as agglomerations. Rare muscovite, garnet, cordierite, sillimanite, and megacrysts of andalusite are found within the granite. Accessory minerals include apatite, zircon, corundum, and tourmaline.

Andalusite megacrysts appear to have not precipitated directly from the magma. This is evident in their higher concentration near the contact zone, the presence of chiastolite and, the development of reaction rims. Based on this evidence andalusite megacrysts were not included in whole rock analysis (see Chapter 3).

The OOB (and in general the Jebilet granites) contain most of the characteristic peraluminous minerals (Clarke, 1981), i.e biotite, muscovite, aluminosilicates, cordierite, garnet, tourmaline, spinel and, corundum. However, in most cases the origin of these minerals remains problematic, and will need to be resolved by future workers.

The leucogranites of the OOB were not sampled during this study. Although some leucogranites have been reported within the batholith (Huvelin, 1977) they are mainly found within the Bramram greisen (not discussed in this thesis because of their high degree of alteration).

Aplites with abundant microcline, albite, oligoclase, muscovite, rare biotite, and accessory brown tourmaline occur as dykes or sheets cutting the monzogranites and granodiorites. Aplitic dykes have also been observed crosscutting hornfels west of the OOB. An aplite dyke was sampled during this study (JBL1B) and was classified as a monzogranite on a Streckeisen QAP diagram (Figure 2.3). It should be pointed out that even though this sample showed evidence of considerable alteration (sericitization, chloritization) it was selected for chemical analyses because it was the only aplite available.

Pegmatitic dykes occur almost exclusively in the country rock and very rarely are they found intruding the granites (Huvelin, 1977). They were not sampled during this study.

2.3.1.3 Tabouchennt-Bamega Pluton

The Tabouchennt-Bamega pluton (TBP) is located north of Marrakech and west of the main highway leading to Casablanca. The pluton crops out over an area of approximately 50 km^2. Unfortunately Quaternary deposits cover a large area of the pluton and have made sampling of the granite difficult. Sixteen samples were collected from the Tabouchennt-Bamega pluton (Figure 2.4). Point-counting and classification results determined using on a Streckeisen QAP diagram are given in Table 2.2 and Figure 2.5. Compositions within the Tabouchennt-Bamega pluton are essentially monzogranitic, except for specimen BRR10a, which is a granodiorite.

The TBP presents many similarities with the OOB and descriptions given of the OOB generally apply for the TBP. Unlike the OOB no megacryst of andalusite and few enclaves have been observed in the TBP. The TBP has a higher concentration of alkali feldspars indicating that the TBP may represent a more evolved member in the differentiation sequence than the OOB.

2.3.2 Rehamna Massif

2.3.2.1 Introduction

The Rehamna massif is located approximately 50 km north of the Jebilet massif (Figure 1.2). Granitoids of weakly peraluminous composition occur in the southern part of the massif and intrude rocks

Tabouchennt-Bamega Pluton

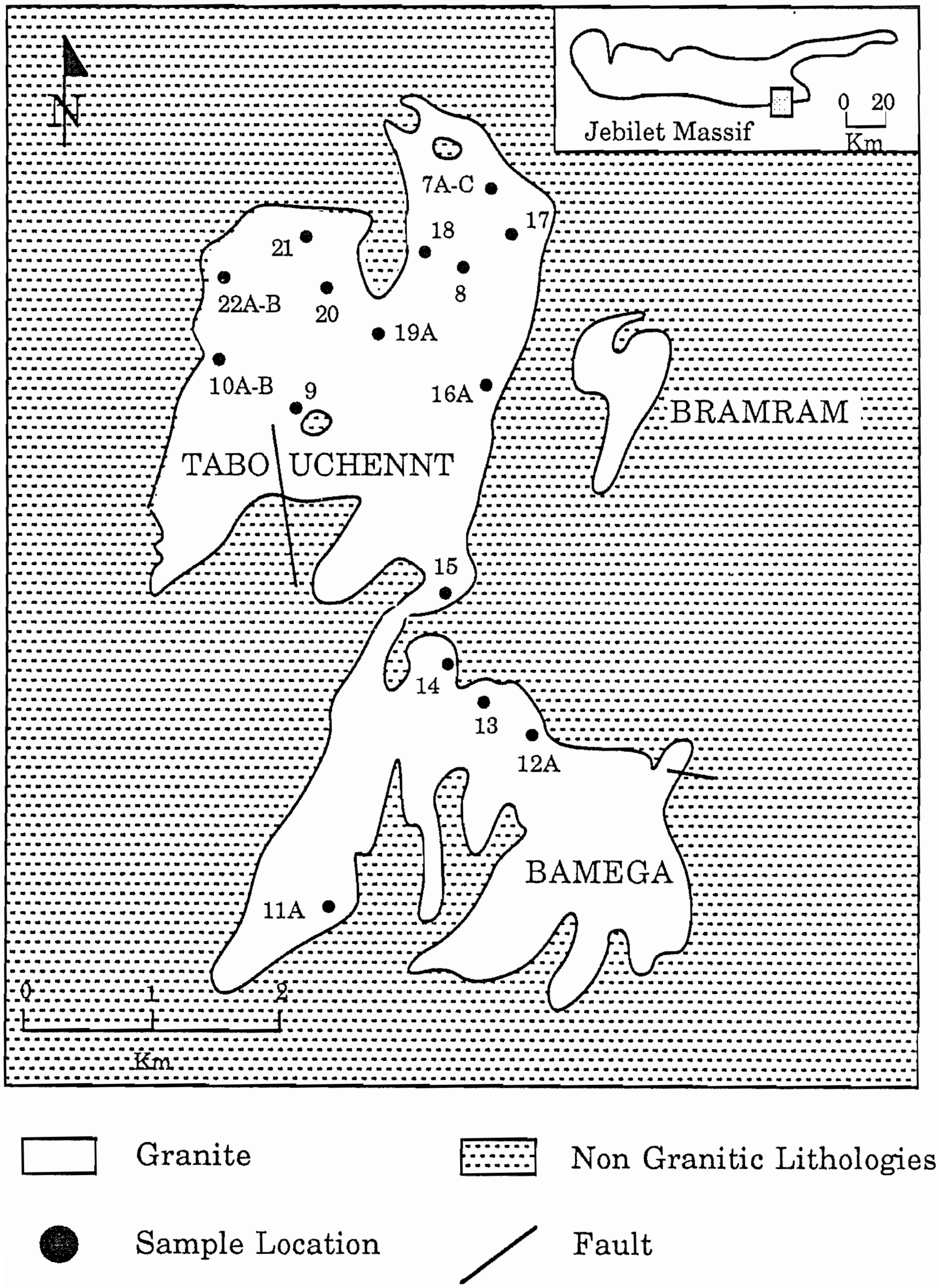


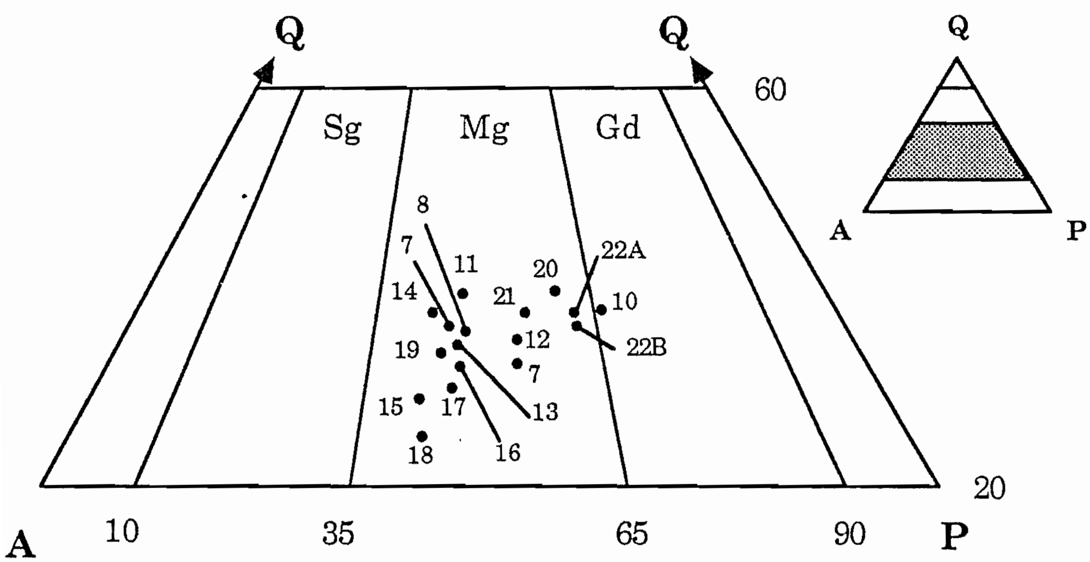
Figure 2.4. Location of samples collected from the Tabouchennt-Bamega pluton.

Table 2.2. Modal analysis of samples from the Tabouchennt-Bamega pluton (Jebilet Massif). Based on stained slabs counting, 1000-2000 points. See Figure 2.5 for plot of QAP diagram.

SAMPLE	BRR7	BRR8	BRR10	BRR11	BRR12	BRR13	BRR14	BRR15
Quartz	29.9	33.7	33.3	37.0	30.7	31.3	35.4	26.8
Plagioclase	34.6	28.2	37.0	25.8	32.4	26.9	25.0	27.0
K-Feldspar	28.8	31.7	19.4	31.0	26.5	32.6	33.5	39.1
Biotite	5.8	4.7	9.0	5.2	8.7	8.4	5.1	5.8
Muscovite	1.0	1.8	1.4	1.0	1.7	0.9	1.1	1.4
Rock name	Mg	Mg	Gd	Mg	Mg	Mg	Mg	Mg
SAMPLE	BRR16	BRR17	BRR18	BRR19	BRR20	BRR21	BRR22A	BRR22B
Quartz	28.6	26.2	24.0	30.8	35.1	34.9	33.3	34.2
Plagioclase	27.8	28.3	28.7	26.9	33.2	32.2	36.3	36.4
K-Feldspar	32.6	35.1	42.6	35.0	21.4	26.3	20.6	20.3
Biotite	9.3	9.3	3.8	6.5	8.9	4.6	8.2	8.0
Muscovite	1.7	1.1	0.9	0.8	1.4	2.1	1.6	1.1
Rock name	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg

Mg = monzogranite Gd = granodiorite

Tabouchennt-Bamega Pluton



Sg = syenogranite Mg = monzogranite Gd = granodiorite

Figure 2.5. QAP (Quartz- Alkali Feldspar- Plagioclase) plot of modal analysis from the Tabouchennt-Bamega pluton (Jebilet Massif, Morocco). See Table 2.2 for modal analysis and Figure 2.4 for sample locations. Classification after Streckeisen, 1976.

ranging from Cambrian? to upper Visean? in age. The country rock is reported to be of the highest metamorphic grade encountered in the Meseta (Michard, 1976, 1982). The Rehamna granites are also believed to correspond to the apex of a larger batholith occurring beneath the micashists.

Although many studies have been undertaken on the Rehamna massif, very little is known about the granitic rocks which comprise this massif. Granites of the Sebt de Brikiine batholith and the Ajar el Bark stock were sampled.

2.3.2.2 Sebt de Brikiine Batholith

Sixteen samples were collected from the Sebt de Brikiine batholith (also referred to as the Si-Mohamed-Jerari batholith) (Figure 2.6). Point counting and classification results according to Streckeisen (1976) are given in Table 2.3 and Figure 2.7. Compositions within the Sebt de Brikiine batholith are essentially monzogranitic, with one exception SDB7 which was classified as a syenogranite (Figure 2.6), all of which generally cluster as one coherent population. Mrini (1985) reported that the granite may be classified as a calc-alkaline or a differentiated alkaline suite of the monzonitic series of Lameyre (1982). This can not be confirmed given the limited number of samples on Figure 2.6. If her observation is correct this would suggest a difference in the crystallisation history of the Rehamna and Jebilet granites (which are clearly of the calc-alcaline series) (Figure 2.2 and 2.4).

The SDB is a fine- to coarse-grained assemblage of quartz, K-feldspar, plagioclase, sparse biotite (more abundant in the east) and muscovite, and rare tourmaline (Mrini, 1985). Microscopic sphene and magnetite have also been reported (Gigout, 1951). Idir E.H. (pers. comm.) suggested that these minerals appear to be related to a much later faulting event and would not have crystallized directly from the magma. Mrini (1985) reported that the granite does not contain any

Sebt De Brikiine Batholith

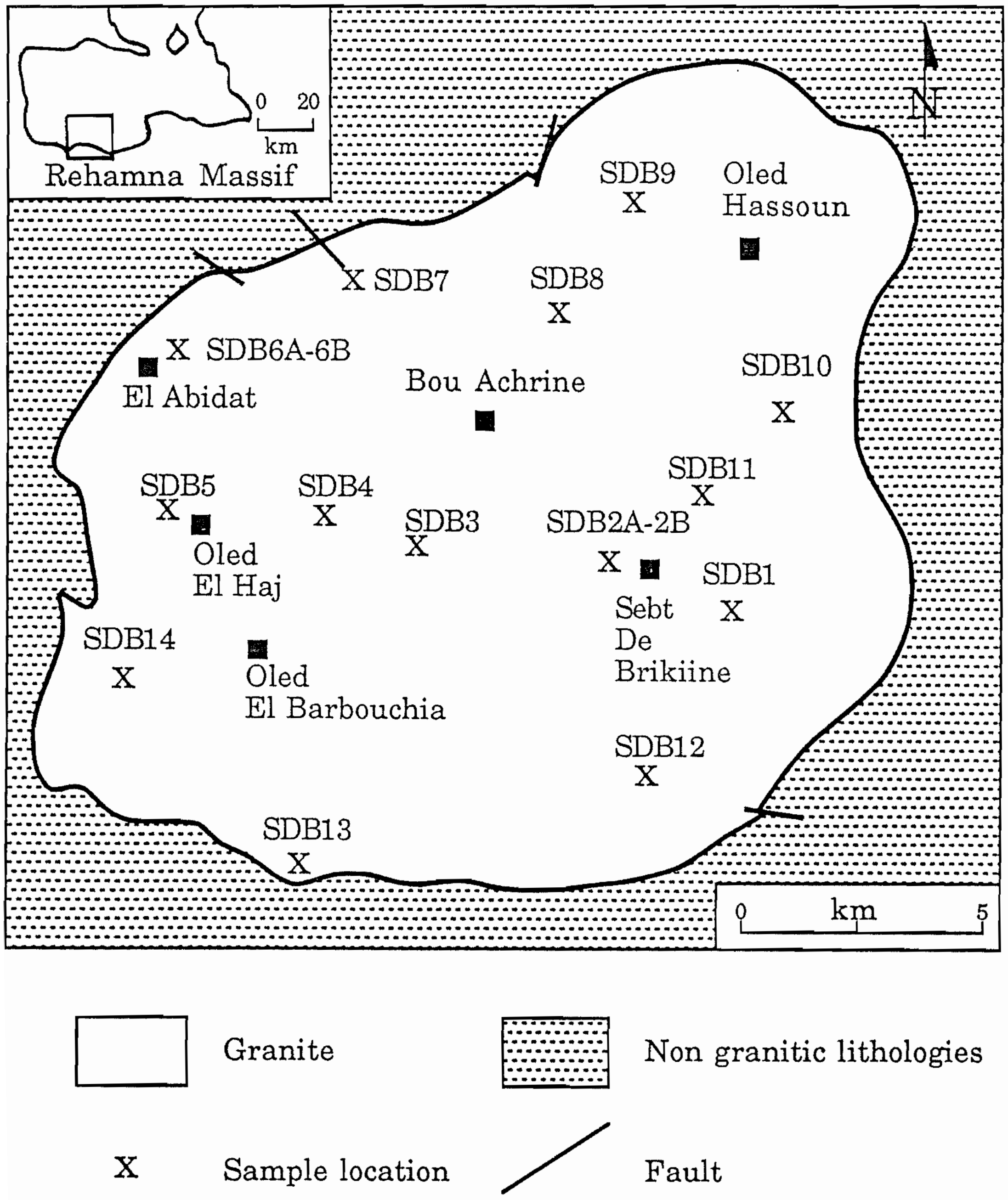


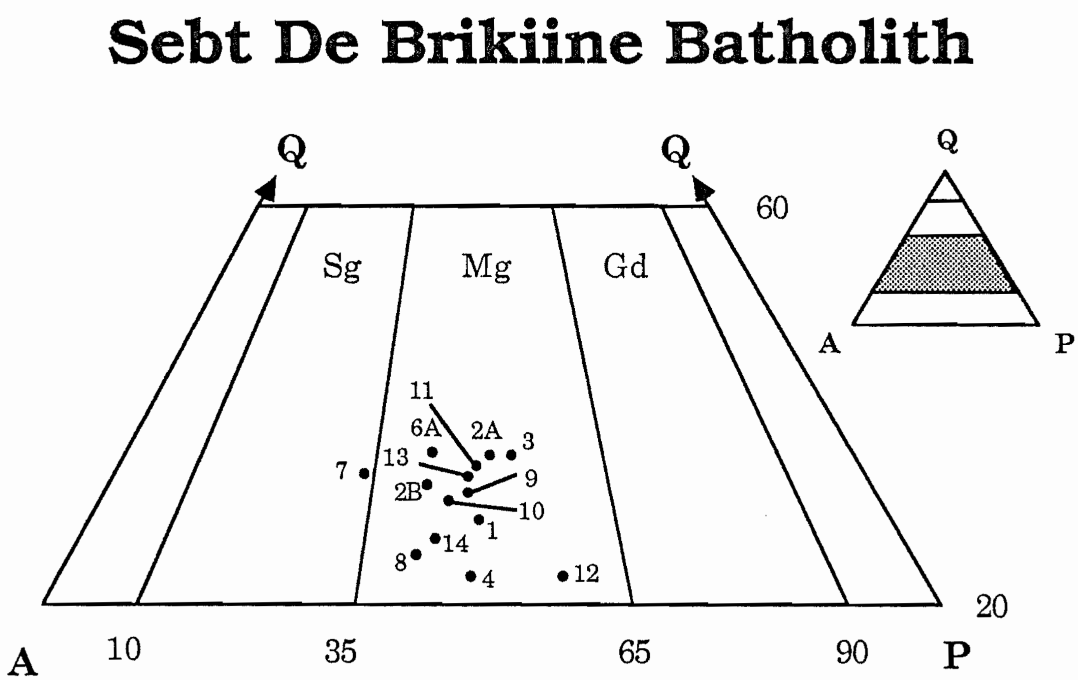
Figure 2.6. Location of samples collected from the Sebt de Brikiine batholith.

Table 2.3. Modal analysis of samples from the Sebt de Brikiine batholith (Rehamna Massif). Based on stained slabs counting, 1000-2000 points. See Figure 2.7 for plot of QAP diagram.

SAMPLE	SDB1	SDB2A	SDB2B	SDB3	SDB4	SDB5	SDB6A	SDB6B
Quartz	27.6	34.0	30.0	33.9	21.6	30.1	24.0	30.9
Plagioclase	33.4	29.9	27.4	33.6	36.8	30.5	19.6	28.6
K-Feldspar	38.5	33.8	42.0	30.4	40.7	35.0	28.5	37.9
Biotite	0.4	2.3	0.6	2.0	1.0	4.1	27.9	2.7
Muscovite	0.2	tr.	tr.	tr.	tr.	0.3	tr.	tr.
Rock name	Mg	Mg	Mg	Mg	Mg	Mg	Mg	Mg
SAMPLE	SDB7	SDB8	SDB9	SDB10	SDB11	SDB12	SDB13	SDB14
Quartz	30.5	24.1	30.4	28.8	31.2	20.9	30.9	25.3
Plagioclase	23.2	30.5	31.9	31.0	30.4	43.1	30.6	30.8
K-Feldspar	44.7	44.4	37.2	38.6	35.7	32.1	36.9	43.0
Biotite	1.6	0.9	0.6	1.6	2.6	3.6	1.6	0.9
Muscovite	tr.	tr.	tr.	tr.	tr.	0.3	tr.	tr.
Rock name	Sg	Mg	Mg	Mg	Mg	Mg	Mg	Mg

Mg = monzogranite Sg = syenogranite

tr.= trace



Sg = syenogranite Mg = monzogranite Gd = granodiorite

Figure 2.7. QAP (Quartz- Alkali Feldspar- Plagioclase) plot of modal analysis from the Sebt de Brikiine batholith (Rehamna Massif, Morocco). See Table 2.3 for modal analysis and Figure 2.6 for sample locations. Classification after Streckeisen, 1976.

enclaves from the country rock; however, Gigout (1951) noted the presence of enclaves near the contact zone in the Douar Souala vicinity. No xenolithic enclaves were observed by this author, however clots of biotite were found which may represent assimilated xenolithic material, this is still unclear. Perhaps the most striking features of the SDB are its pink color, which contrasts markedly with the usual grey-white color of other Moroccan granites, and the absence of peraluminous minerals, observed in the Jebilet granites and characteristic of many of the Nova Scotian granites (Clarke, 1981; MacDonald and Clarke, 1985).

2.3.2.3 Ajar El Bark Stock

The Ajar El Bark stock, once used as a quarry, covers an area of approximately 1 Km^2 and is located SE of Ben Guerir. Six samples were collected from the Ajar El Bark Stock (Figure 2.8). Point counting and classification results are given in Table 2.4 and Figure 2.9. Specimens are monzogranitic in composition and varied in grain size. They are identical to SDB both in color and mineralogical composition.

2.3.2.4 Ras El Abiod Pluton

The Ras El Abiod pluton (REA) is a peraluminous muscovite-granite of variable grain size (Morin, 1951; Gigout, 1951) and crops out over an area of approximately 8 Km^2 (Figure 2.6). It is composed of quartz, K-feldspar, sodic plagioclase, rare biotite (most often chloritized) and, abundant muscovite (Hoepffner, 1982). The granite clearly shows a pneumatolitic tendency with the development of quartz-rich greisens and muscovite rosettes (Chauris and Huvelin, 1964). The granite will often contain tourmaline, and may include "minuscule" garnets (Gigout, 1951). It is gray to pink in colour, and may sometimes be red, where fluid interaction was at its greatest.

Aplitic dykes and small bodies occur throughout the pluton and commonly contain tourmaline. Pegmatites within the pluton usually

Ajar El Bark Stock

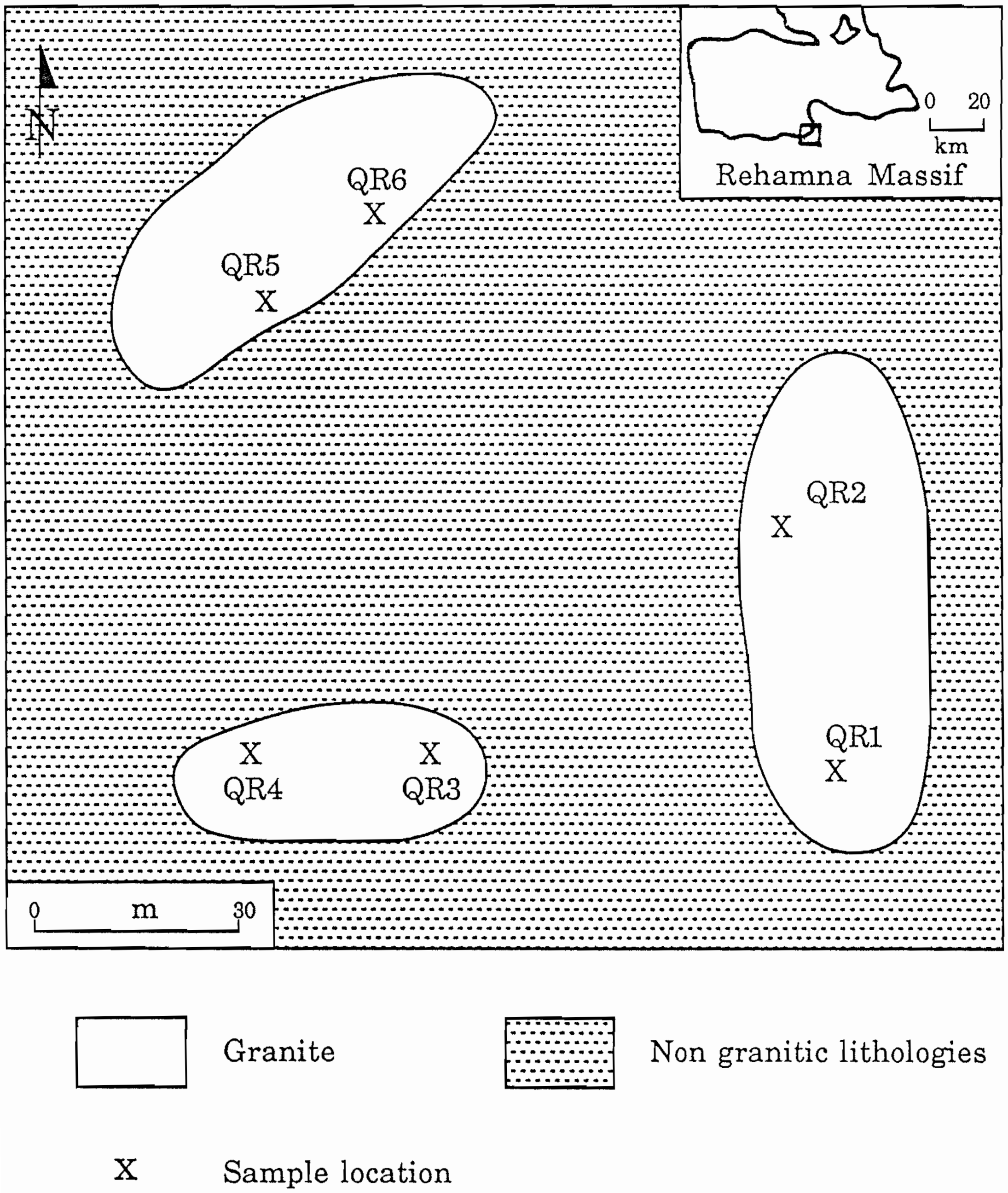


Figure 2.8. Location of samples collected from the Ajar El Bark stock.

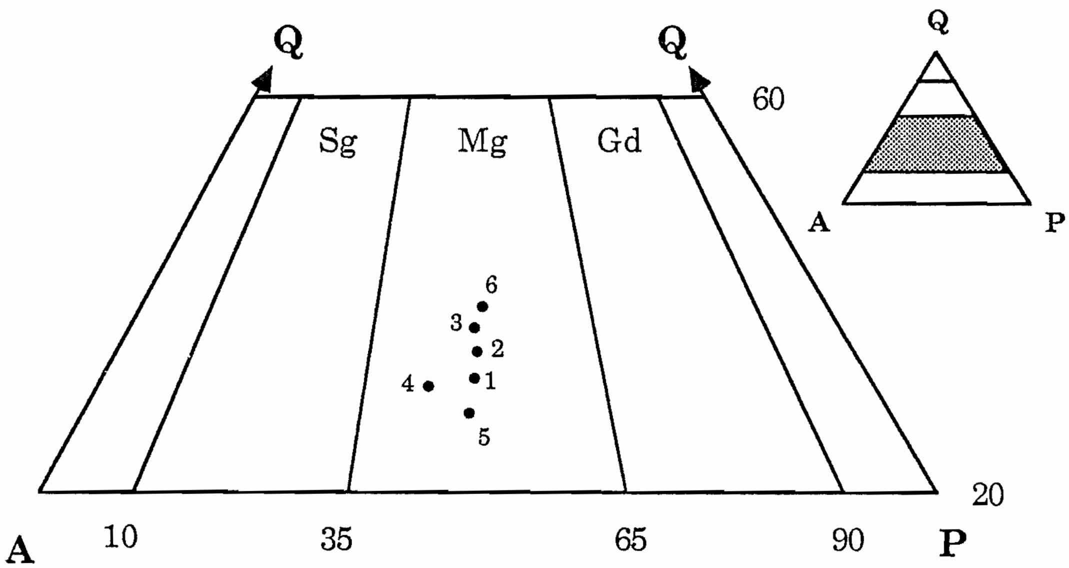
Table 2.4. Modal analysis of samples from the Ajar El Bark stock (Rehamna Massif). Based on stained slabs counting, 1000-2000 points. See Figure 2.9 for plot of QAP diagram.

SAMPLE	QR1	QR2	QR3	QR4	QR5	QR6
Quartz	30.7	34.0	34.9	30.1	27.2	36.1
Plagioclase	32.0	29.5	28.1	27.6	32.3	28.9
K-Feldspar	34.8	33.5	32.7	39.9	38.8	32.4
Biotite	2.4	2.4	4.1	2.4	1.8	2.5
Muscovite	0.1	0.6	0.2	tr.	tr.	0.2
Rock name	Mg	Mg	Mg	Mg	Mg	Mg

Mg = monzogranite

tr.= trace

Ajar El Bark Stock



Sg = syenogranite Mg = monzogranite Gd = granodiorite

Figure 2.9. QAP (Quartz- Alkali Feldspar- Plagioclase) plot of modal analysis from the Ajar el Bark stock (Rehamna Massif, Morocco). See Table 2.4 for modal analysis and Figure 2.8 for sample locations. Classification after Streckeisen, 1976.

occur as small pockets (or miarolitic cavities) and contain tourmaline. A pegmatite containing crystals of beryl has also been reported intruding the country rock (Chauris and Huvelin, 1964).

Although the granite was sampled in some detail (48 specimens) its altered state rendered it "unsuitable" for this study.

2.3.3 Central Massif

2.3.3.1 Introduction

The Central massif is the northermost massif considered in this study. The characteristics of the Zaer, Ment and Oulmes plutons as described by previous authors are given below.

2.3.3.2 Zaer Pluton

The Zaer pluton, probably one of the better-known granitic bodies of Morocco has been the subject of many recent studies (Mrini, 1985; Guiliani, 1982; Guiliani and Sonet, 1982; Mahmood, 1980; 1984; 1985). The pluton is principally composed of a two-mica monzogranite (two-mica granite) that intrudes a biotite granodiorite (biotite granite). More detailed divisions have been suggested (Guiliani, 1982, Mahmood,1980), however these constitute more refinement than is needed for this study.

Modal mineralogical studies of the Zaer pluton conducted by Mahmood (1980) and Guiliani (1982) revealed that compositions within the granite generally range from tonalite to syenogranite on a Streckeisen diagram, with some quartz diorites. Both the biotite granite and the two-mica granite belong to the calc-alkaline series as defined by Lameyre (1980). The granite of varied grain size is mainly an assemblage of quartz, plagioclase, K-feldspar, biotite and muscovite. Accessory minerals include ilmenite, rutile, apatite, zircon, rare sphene and monazite (only found in the most mafic facies). Very rare garnet and andalusite have also been reported in the muscovite-bearing facies of the granite (Mahmood and Bennani, 1984). Detailed mineralogical work caried out by Guiliani (1982) has revealed some "significant" differences in the evolution of the biotite granites and two-mica granites. This is also supported by chemical evidence. Minor facies within the pluton include a muscovite leucogranite and some aplitic bodies.

2.3.3.3 Ment Pluton

The Ment pluton located north of Aguelmous can be divided into two rock types: biotite granite and leucogranites (Boushaba, 1984). The biotite granites (or monzogranites and syenogranites on a Streckeisen diagram) account for most of the exposed area and can be further subdivided into a porphyritic and a non-porphyritic subfacies. The latter is characterized by the absence of phenocrysts of K-feldspar and enclaves. The biotite granites generally contain quartz, K-feldspar, plagioclase, biotite with minor amounts of zircon, apatite, topaz and rare hematite inclusions in the biotite. The biotite granites are comparable to the biotite granite of the Zaer pluton (Boushara, 1984). A second minor facies of the pluton, the leucogranites, are essentially found in the north-western part of the pluton. They include quartz, plagioclase, K-feldspar, muscovite and may contain siderophyllite topaz, zinnwaldite and very rare biotite (Boushara, 1984). As a result of intense tourmalinisation, tourmaline can be found throughout the pluton.

2.3.3.4 Oulmes Pluton

The Oulmes massif located some 100 Km east of Rabat, covers an area of approximately 30 Km^2. Although many different facies have been described for the Oulmes pluton (Termier et al., 1950) it can generally be divided into two main rock types: two-mica granites and muscovite granites (Mahmood, 1980; Mahmood and Bennani, 1984; Mrini, 1985). Both can be classified as monzogranites on a Streickeisen diagram (Mahmood, 1980). In addition to the usual quartz, K-feldspar, plagioclase, muscovite and rare biotite, minerals such as garnet, andalusite, cordierite, tourmaline, accessory zircon, apatite and, ilmenite have been reported in the Oulmes pluton. High fluid activity is evident with the presence of primary tourmaline as a main phase in some parts of the granite. Aplites, pegmatites and quartz veins are also reported thoughout the pluton (Termier et al., 1950). The Oulmes monzogranites are reported to be very similar to the two-mica facies of the Zaer pluton (Mahmood, 1980)

2.3.4 Atlas Domain

2.3.4.1 Introduction

The granites of the Atlas domain are the southernmost and easternmost plutons considered in this study. They include the Tichka, Azegour, Aouli and Bou Mia plutons and are described below.

2.3.4.2 Tichka Complex

The Tichka complex located some 100 km SW of Marrakech, covers an area of approximately 320 km^2. With a vertical relief of about 2000 m the massif represents one of the better exposed plutons of Morocco and, as such, has been the subject of many recent studies (Termier et al., 1971; Vogel and Walker, 1975; Vogel et al., 1976; Scott and Vogel, 1980; Termier, 1982; Lagarde and Roddaz, 1983; Mrini, 1985; Gasquet et al, in prep.). The Tichka rocks were emplaced during the Westphalian into mostly Cambrian rocks (Termier et al. 1972). According to Gasquet et al. in prep.) the Tichka massif can be divided into 4 distinct groups: 1) gabbros, 2) diorites, 3) granites and 4) late stage aplites and pegmatites.

The gabbros can be further subdivided into olivine and pyroxene bearing facies and include, cumulate plagioclase, green and/or brown hornblende and locally orthopyroxene. The diorite may be fine grained or porphyritic and has been described as hornblende diorites and quartz diorites (Lagarde and Roddaz, 1983). These rocks are somewhat heterogenous in composition and are reported to contain smaller amounts of gabbro and granodiorite (Vogel et al. 1976).

The granitoids are generally discussed with reference to two groups (Vogel et al. 1976; Scott and Vogel, 1980; Lagarde and Roddaz, 1983): the southern and northern granites. The granites in the southern portion of the massif include monzogranites, granodiorites and tonalites. They are porphyritic and contain biotite, amphibole, sphene, apatite and allanite. The northern granites are non-porphyritic and sometimes almost pegmatitic. The latter are characterized by the absence of hornblende and enclaves of quartz diorite. Hornblende is rarely present in the non-porphyritic variety and not reported in the "pegmatitic" granite.

The late stage dykes present a duality in composition and can either be felsic (aplites and pegmatites) or mafic (microgabbros and dolerites).

The duality of magmatism in the Tichka complex and in particular the presence of a possible mantle component will be readressed in Chapter 3.

2.3.4.3 Azegour, Aouli and Bou Mia Plutons

The Azegour pluton of the High-Atlas and the Aouli and Bou Mia plutons of the Middle-Atlas are of minimal importance to this thesis and therefore require only a brief mention (Figure 1.3).

The Azegour pluton located east of the Tichka massif has been described as an evolved monzogranite and syenogranite belonging to the calc-alkaline monzonitic series of Lameyre (1982) (Mrini, 1985).

The Aouli and Bou Mia plutons of the Middle Atlas (east of the Meseta) contain diorites, granodiorites and monzogranites) and, calc-alkaline granites respectively (Tisserant, 1977; Mrini, 1985).

2.3.5 Emplacement of the Moroccan Granites

The granites of the Jebilet Massif intrude a sequence of volcano-sedimentary rocks, folded during Late Visean-Namurian time. This suggests a post-Visean age for their emplacement. Although these granites are generally considered to be post-tectonic, some evidence suggests at least a partial syn-tectonic history for these rocks (Huvelin, 1977; Lagarde and Choukroune, 1982). Contact metamorphic minerals such as chlorite, biotite and andalusite are stretched and deformed in the plane of the schistosity. The trajectory of the schistosity is reported in some areas to affect the plutons (south of the TBP and Bramram). Megazones of ductile shearing of S-SE direction and sinistrial displacement offer further evidence for partial syn-tectonic emplacement for these plutons. Abundant hornfels and the preservation of contact minerals (such as post-tectonic equant biotite) in rocks affected by moderately low grade regional metamorphism indicate that the granites remained active after the effects of the Hercynian deformation had ceased (Huvelin, 1977).

The Rehamna granites were emplaced in micaschist of the mesozone (garnet straurolite and kyanite assemblages). The presence of pegmatitic dykes of the Ras El Abiod pluton, which cut the final phase of the Hercynian deformation (Jenny, 1974) and the development of contact metamorphic minerals which clearly postdate the regional metamorphism (the latter occasionaly retrograded in the contact aureoles of the granites) indicate a post-tectonic emplacement for the granites of the Rehamna massif (Pique, 1972; Hoepffner, 1974; Jenny, 1974; Huvelin, 1977; Michard, 1982).

The granites of the Central massif are generaly considered to be syn- to post-tectonic (all display a contact aureole). The Zaer pluton intrudes a sequence of schist, quartzites and carbonates ranging from Cambro-Ordovician to Devonian in age and of low-grade regional metamorphism. The Ment pluton intrudes sandstones and carbonates of upper Visean age, flysch of Namurian age, and Cambro-Ordovician schist. Foliation of contact aureole minerals in the Cambro-Ordovician rocks suggest a partial syn-tectonic (Hercynian) emplacement for the Oulmes granite (Boushaba, 1985; Pique, 1976)

The Tichka massif of the Atlas domain was emplaced in a series essentially Cambrian in age. The massif is syn to post-Hercynian, with a development of a contact aureole in a terrane characterized by epizonal metamorphism.

2.3.6 Geochronology of the Moroccan Granites

Geochronological data for the Moroccan granites determined using the Rb-Sr method by Mrini (1985) and Tisserant (1976) are summarized in Figure 2.10. Magmatism in Morocco ranges from the Visean (340 Ma) to the Permian (245 Ma). No clear regional patterns or zonations of these ages are evident in the area.

$^{87}Rb/^{86}Sr$ isotopic analyses of the Oulad Ouaslam batholith, Tabouchennt-Bamega pluton and, Bramram greisen suggest that magmatism lasted at least 10 million years and occurred between 330 and 340 Ma ago in the Jebilet Massif (Mrini, 1985).

The Sebt de Brikiine batholith and Ajar El Bark stock were dated at 268 $\pm$ 6 Ma (both massifs were used for the age determination) (Mrini, 1985). An approximate age of 265 Ma was determined for the leucogranites of the Ras El Abiod pluton (Mrini, 1985).

$^{87}Rb/^{86}Sr$ analyses of the Zaer pluton indicate an age of 303 $\pm$ 13 Ma for the biotite granite (tonalite-granodiorite) and 279 $\pm$ 11 Ma for the two-mica granite (monzogranite) (Mrini, 1985). The biotite granite facies of the Ment pluton was emplaced some 279 $\pm$ 6 Ma and the

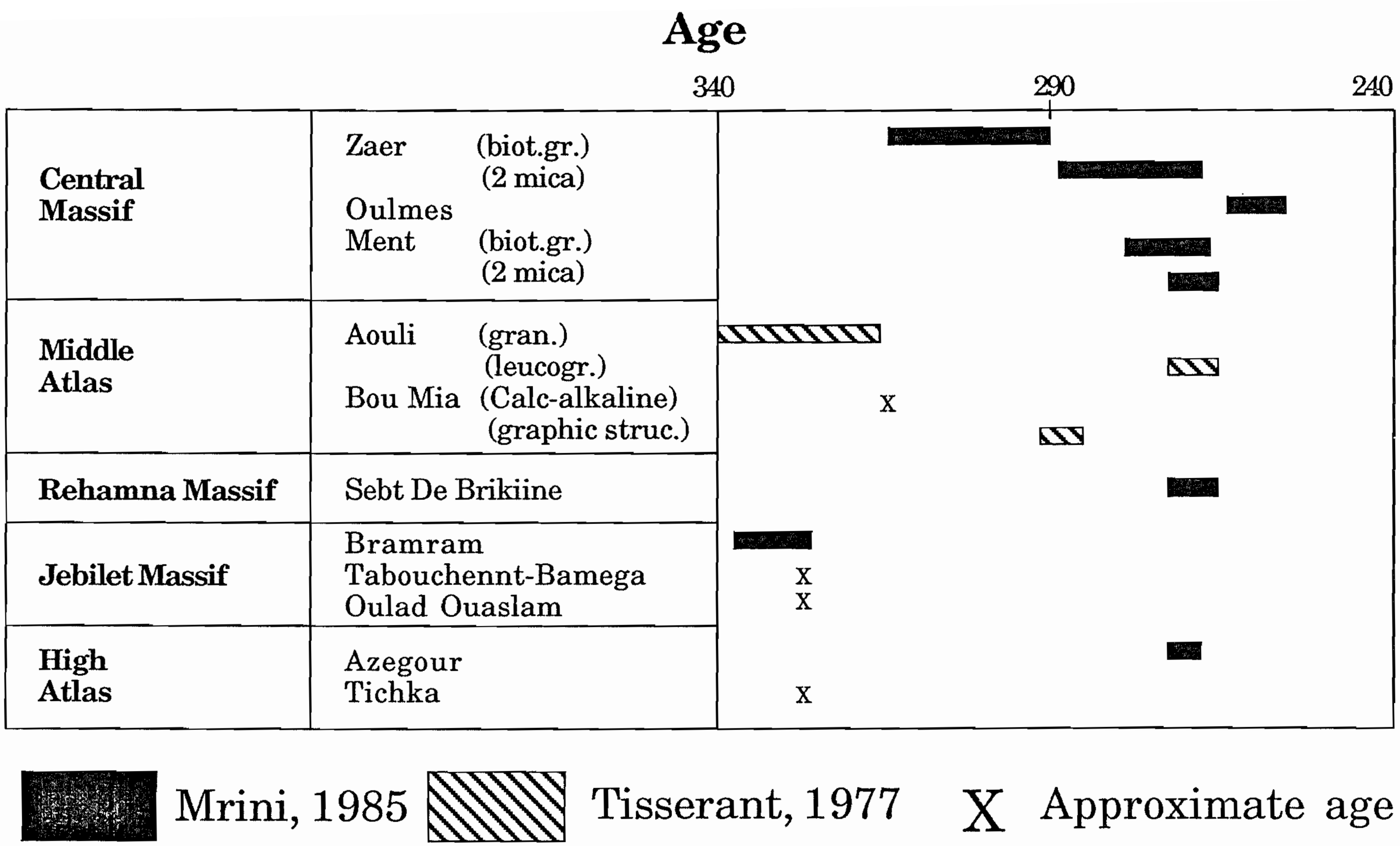


Figure 2.10. Sr ages for the Moroccan granites data from Mrini, 1985 and Tisserant, 1977.

leucogranite facies was dated at 270 $\pm$ 3 Ma. The age of the Oulmes pluton was estimated at 298 Ma (Mrini, 1985).

In the Atlas domain an approximate age of 330 Ma was reported for the emplacement of the Tichka complex (Mrini, 1985). The Azegour pluton is reported to have been emplaced some 271 $\pm$ 3 Ma ago (Mrini, 1985). The Aouli and Bou Mia granites of the Middle Atlas as determined by Tisserant (1977) are reported to range from 270-330 Ma in age.

2.3.7 Summary of the Moroccan Granites

Magmatism in Paleozoic terranes of the Meseta and Atlas domains of Morocco cover a wide range of time from approximately 330 Ma to 245 Ma. Compositions within and between the plutons are also quite varied. The granites intrude rocks of varied composition and age (from Cambrian to Upper Visean). The granites were intruded into sequences which have undergone different degrees of metamorphism. Evidence also suggests that these were emplaced at different crustal levels. All of these factors will of course contribute complexity to the problem of characterizing Moroccan magmatism.

2.4 Comparison of the Geochronology of the Nova Scotian and Moroccan Granites

Perhaps one of the most contentious issues in this study is the significance of the difference in timing between magmatism in Morocco and Nova Scotia. A basic assumption of this thesis is that granite compositions have more to do with the source and the sum of processes which affect the granite throughout its evolution than with time itself, and even though the magmatism in Nova Scotia and Morocco is different, their granite populations may show some geochemical similarities (Clarke and Richard, 1986).

When the granites of Nova Scotia were first dated the southern plutons appeared to be younger than the northern plutons. Upon further detailed analyses of the granites it became evident that the southern plutons were in fact generally emplaced at the same time as the northern plutons. The younger ages obtained for the southern plutons were the result of a tectono-thermal reset event. It is not unreasonable to expect that the granites of Morocco may have been similarly affected by such an event and perhaps future workers may discover that the Moroccan granites are in effect older than first believed.

CHAPTER 3

GEOCHEMISTRY

3.1 Introduction

The advent of abundant and high-quality geochemical data opens new avenues of investigation and interpretation of geochemical data. In particular, as geochemical databases increase in size, multivariate statistical analyses may now be applied. In this thesis the geochemical data from Nova Scotia and Morocco are compared using both the traditional (this chapter) and a multivariate statistical approach (Chapter 5). The applicability of such methods to the geochemical data will be assessed in this study (Chapter 4).

In this chapter, the geochemical data are investigated using the traditional approach. The regional characteristics of the Nova Scotian granites are first reviewed. The characteristics of granitic bodies in Morocco are then reviewed. Finally the Nova Scotian and Moroccan granites are compared in order to further assess the viability of the "Moroccan Model".

3.2 Nova Scotian Granites

3.2.1 Introduction

Differences in composition, age and emplacement between the northern and southern peraluminous plutons of the Meguma Zone were outlined in Chapter 2. However, no attempts were made by previous workers to evaluate the scope of these differences from a geochemical point of view. In this section the geochemical data are studied to determine whether a true distinction can be made between the northern and southern plutons.

3.2.2 Major and Trace Elements

A geochemical database of 400 analyses from the Nova Scotian granites was compiled during this study. A complete listing of the data as well as their source references is given in Appendix D.

The basic statistics of the northern (N) and southern (S) plutons of Nova Scotia are presented in Table 3.1. The more varied compositions of the southern plutons relative to the northern plutons are evident when the minimum and maximum values of the major and trace element data are compared (Table 3.1). Although some differences are apparent in the major and trace element contents of these two groups, a clear distinction can not be drawn between the groups simply on the basis of their range, as a great deal of overlap exists between both groups. This is illustrated in Figure 3.1, where the frequency distributions of the various elements were plotted for each group.

Differences between the two populations include a unimodal distribution of K_2O in the N compared with bimodal in the S, and the distributions of CaO, Ba, Rb, Sr, Zr and V. However, the ranges for the N and S populations overlap considerably and separation of the two groups using frequency distributions is not possible.

The visual analysis of histogram data, although of limited use, does show some apparent differences in the distribution of elements within both areas, suggesting that further analyses of these populations are warranted using more "sophisticated" methods, such as basic bivariate statistics and ultimately multivariate statistics.

The mean and standard deviation values of major and trace elements from the northern and southern plutons from Table 3.1 were examined. To aid in the visualisation of the variation, the average and standard deviation values of the northern and southern plutons were plotted on a spider diagram (Figure 3.2). Normalizing values for spidergrams used thoughout this Chapter were drawn from Taylor, 1980 except for

Table 3.1. Basic statistics for major and trace element data from the northern and southern plutons of Nova Scotia.

	North	South	North	South	North	South	North	South
	SiO_2		TiO_2		Al_2O_3		Fe_2O_{3t}	
Minimum	63.93	59.75	0.02	0.02	11.39	12.14	0.17	0.47
Maximum	78.13	76.70	0.82	1.07	17.70	20.18	6.10	6.74
Mean	72.13	70.79	0.24	0.38	14.44	15.18	1.90	2.58
St.Deviation	2.57	3.68	0.17	0.24	0.90	1.35	1.15	1.39
Number	230	153	230	153	230	153	230	153
	MnO		MgO		CaO		Na_2O	
Minimum	0.01	0.02	0.02	0.07	0.28	0.19	2.21	1.52
Maximum	0.60	0.30	1.72	3.62	2.31	5.19	5.02	5.82
Mean	0.06	0.06	0.44	0.95	0.79	1.83	3.58	3.74
St.Deviation	0.06	0.04	0.37	0.76	0.52	1.18	0.45	0.60
Number	230	152	230	153	230	153	230	153
	K_2O		P_2O_5		A/CNK		D.I.	
Minimum	3.15	1.15	0.02	0.03	1.02	0.93	73.92	59.39
Maximum	5.98	6.40	0.87	0.82	1.39	1.46	96.69	95.37
Mean	4.43	3.52	0.24	0.21	1.19	1.15	89.54	83.20
St.Deviation	0.51	1.24	0.12	0.10	0.07	0.09	5.08	8.68
Number	230	153	230	153	230	153	230	153
	Ba		Rb		Sr		Y	
Minimum	2	4	123	36	2	3	3	7
Maximum	963	1200	931	360	248	720	50	35
Mean	282	535	314	138	71	191	15	17
St.Deviation	237	222	155	61	57	135	10	5
Number	232	134	239	147	226	146	87	107
	Zr		Nb		Th		Pb	
Minimum	15	32	1	3	1.0	0.4	4	4
Maximum	267	389	31	29	34.0	44.0	74	36
Mean	84	141	12	11	9.9	7.1	25	19
St.Deviation	47	63	4	5	6.6	7.6	11	7
Number	203	125	134	114	153	119	128	128

Table 3.1 (cont.). Basic statistics for major and trace element data from the northern and southern plutons of Nova Scotia.

	North	South	North	South	North	South	North	South
	Ga		**Zn**		**Cu**		**Ni**	
Minimum	17	12	5	5	1	1	1	1
Maximum	27	26	195	91	104	19	95	47
Mean	22	20	50	53	10	6	11	10
St.Deviation	3	3	24	18	13	4	14	7
Number	45	107	197	129	115	42	117	110
	V		**Cr**		**Hf**		**Cs**	
Minimum	1	1	2	3	1.4	-	5.0	-
Maximum	73	136	404	111	4.2	-	44.2	-
Mean	14	38	38	38	2.7	-	20.5	-
St.Deviation	13	34	57	27	0.8	-	10.5	-
Number	74	104	99	114	15	-	19	-
	Sc		**Ta**		**Co**		**Li**	
Minimum	1	-	0.7	-	1	-	36	19
Maximum	7	-	9.7	-	5	-	801	262
Mean	5	-	5.2	-	2	-	184	73
St.Deviation	1	-	2.7	-	1	-	143	40
Number	26	-	15	-	27	-	128	86
	Be		**B**		**F**		**Cl**	
Minimum	2.0	0.5	3	3	210	60	50	-
Maximum	205.0	20.0	150	50	2400	1300	175	-
Mean	9.8	4.2	22	15	643	428	81	-
St.Deviation	22.8	3.4	18	13	381	218	62	-
Number	83	60	99	15	103	85	4	-
	U		**W**		**Sn**		**Mo**	
Minimum	1.6	0.8	1	4	1	1	0.6	0.8
Maximum	35.0	9.9	19	34	52	31	4.0	10.0
Mean	8.8	3.6	4	17	14	9	1.5	2.6
St.Deviation	6.7	2.0	3	12	12	6	0.7	2.8
Number	122	75	67	6	194	77	130	14

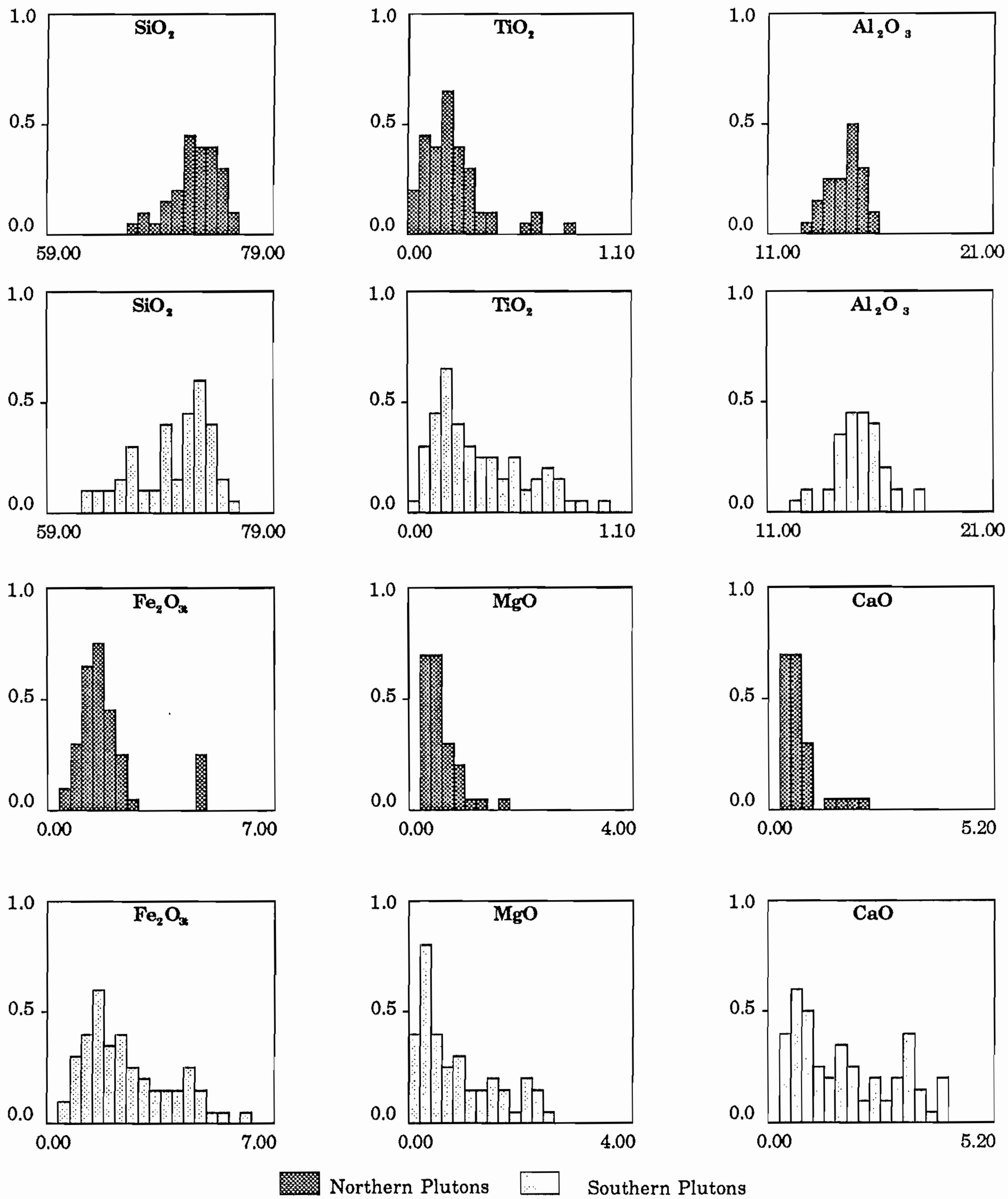


Figure 3.1. Frequency distributions of major and trace element data from Northern and Southern plutons of Nova Scotia. Major oxides in wt % and trace elements in ppm.

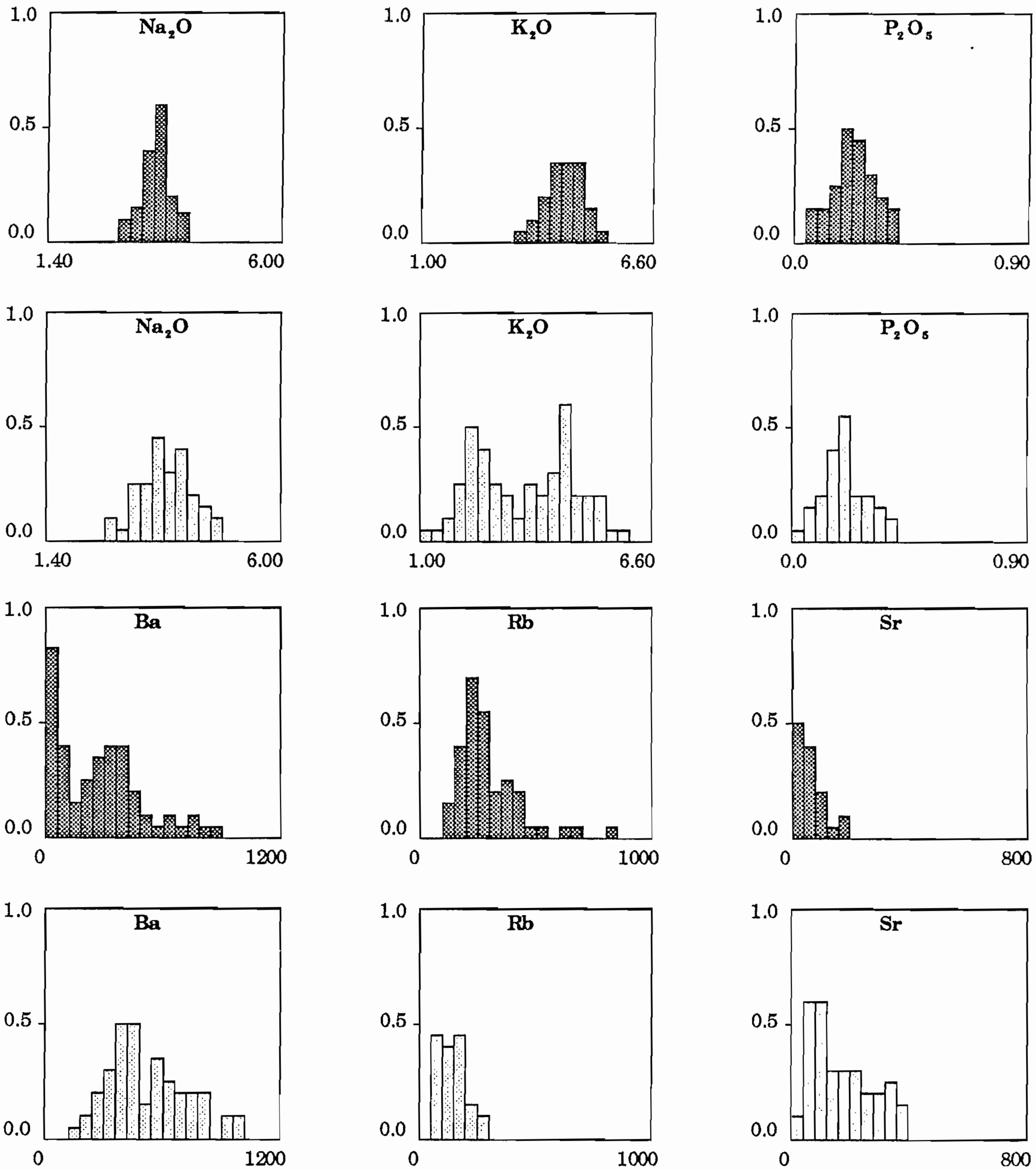


Figure 3.1 (cont.). Frequency distributions of major and trace element data from the Northern and Southern plutons of Nova Scotia.

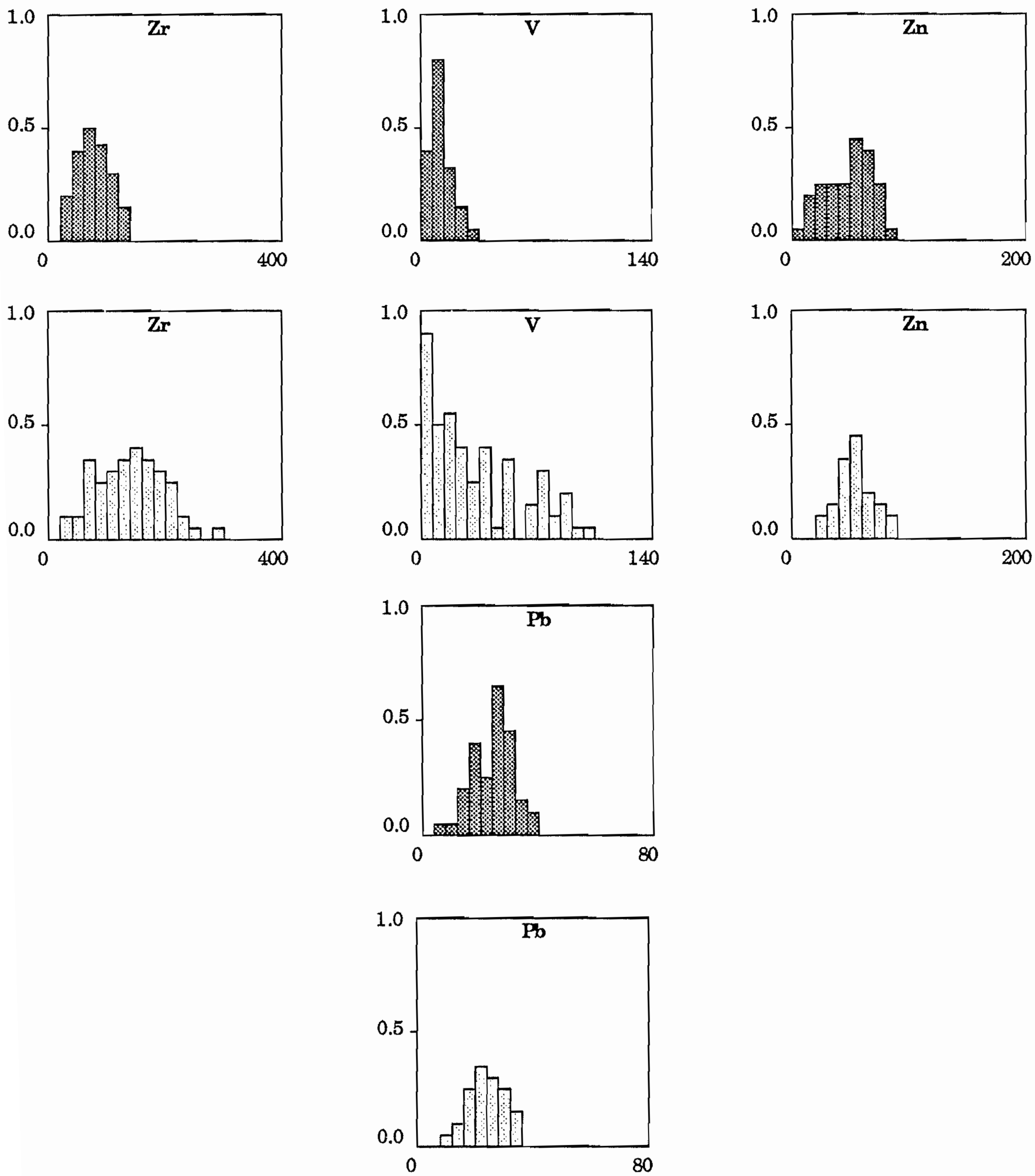


Figure 3.1 (cont.). Frequency distributions of major and trace element data from Northern and Southern plutons of Nova Scotia.

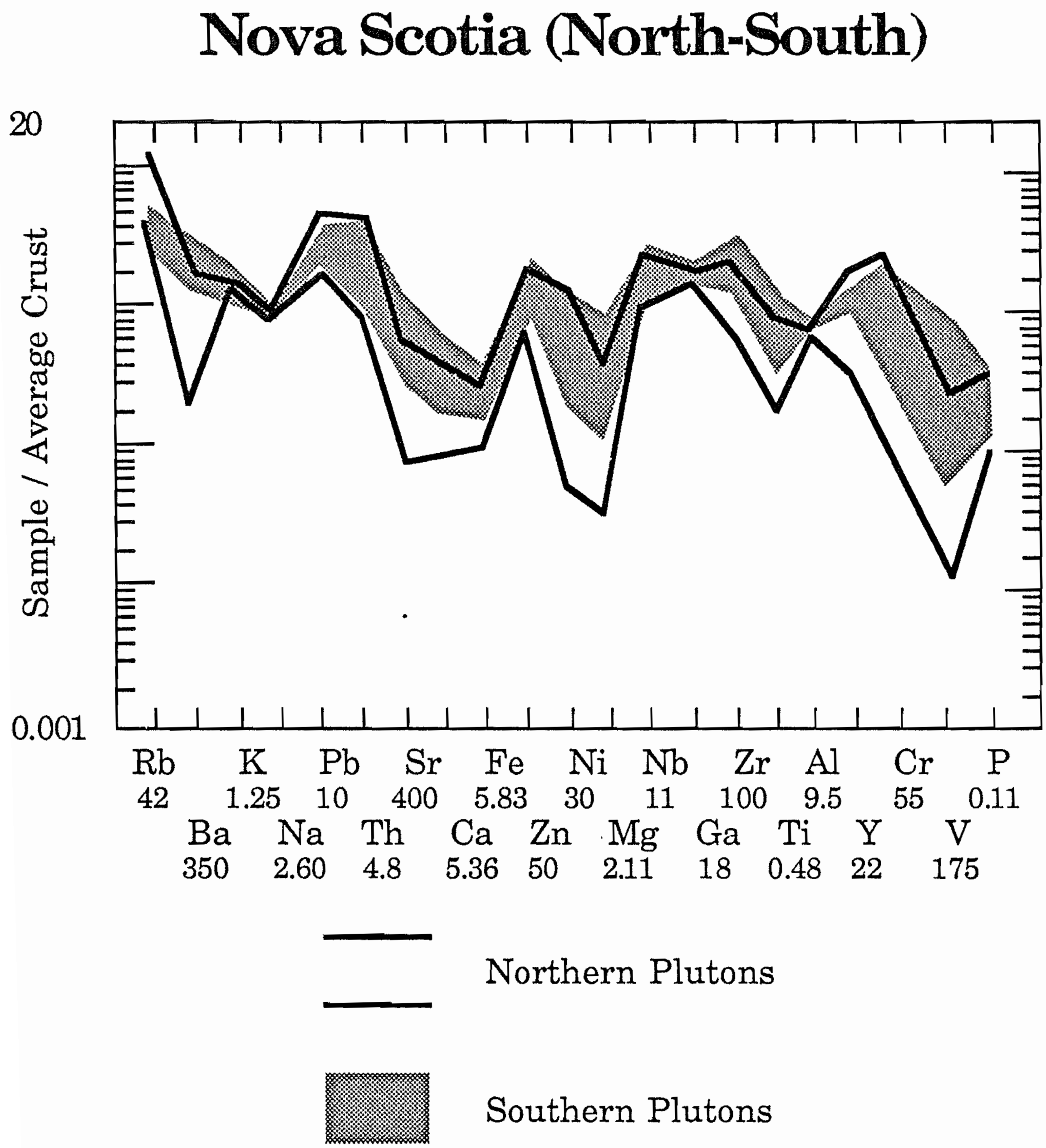
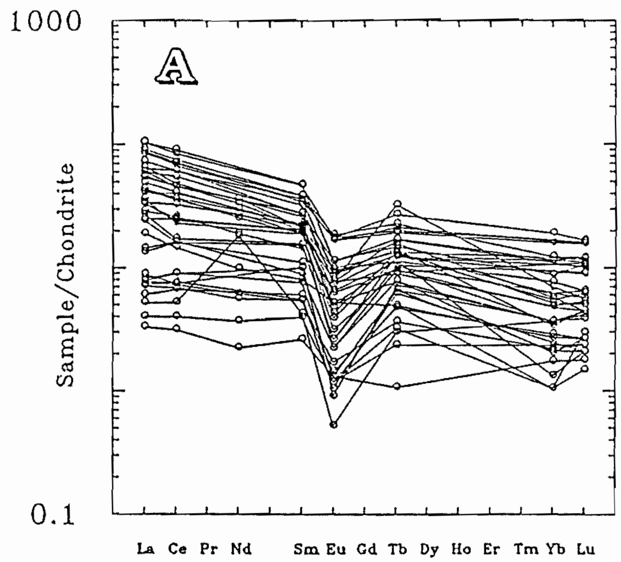


Figure 3.2. Spider diagram comparing the Northern and Southern geochemical populations of Nova Scotia. Each range represents the mean $\pm 1\sigma$.

Nova Scotia (North-South)



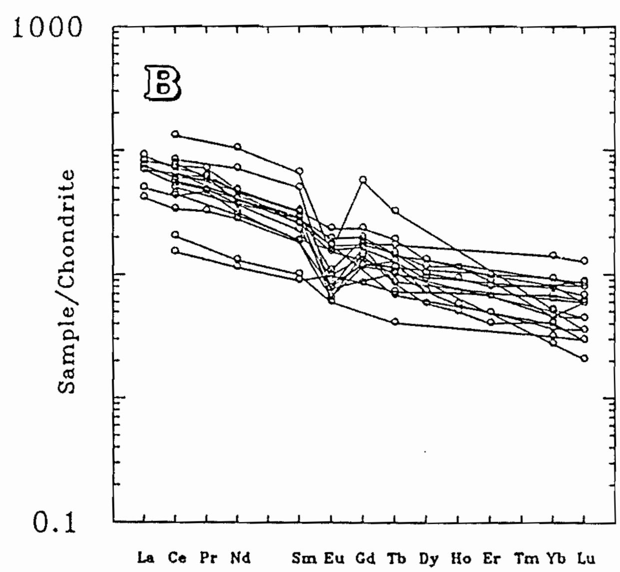


Figure 3.3. REE plots comparing the Northern (A) and Southern (B) plutons of Nova Scotia.

phosphorus which was taken from Allegre and Michard, 1973. The normalizing values used for each element are shown on the diagrams. Both groups display a considerable amount of overlap. Some variation is evident in the generally lower Rb, and higher Ba, Sr, Fe, Mg, and V values of the southern group relative to the north. A spidergram in this case does not appear to be a useful tool in separating the two areas.

Although the mean values for some oxides and trace elements in Table 3.1 and Figure 3.1 suggest some apparent differences between the southern and northern plutons, their variances are generally large. As a result, a great deal of overlap exists between the various populations. Consequently, more detailed analysis of the means may be misleading and was not pursued.

3.2.3 Rare Earth Elements

All available rare earth data from the northern and southern plutons was plotted on Figure 3.2. The limited amount of data within each group has made an adequate comparison difficult. The patterns and values for both groups are very similar, and within analytical error and the uncertainty associated to the fact that these are probably not representative sample populations, they can not be separated.

3.2.4 Isotopic Data

Both oxygen (Longstaffe et al., 1979) and sulfur isotopes (Kubilius, 1983) suggest some difference between the northern and southern compositions. Although the northern and southern plutons appear to have been derived by anatexis of clastic metasedimentary rocks, the southern plutons also appear to contain a more mafic (mantle?) component. This is evident in the lower sample $\delta^{18}O$ and significantly lower $\delta^{34}S$ values within the southern plutons when compared with the northern plutons.

Nd and Sr isotopic data are only available for the northern plutons. These data will be discussed in Section 4.5.1 in which Nova Scotia is compared with Morocco.

3.3 Moroccan granites

3.3.1 Introduction

In this section results of geochemical analysis of samples collected during this study are investigated. The major, trace and rare earth element contents of the Jebilet and Rehamna granites are examined and compared with reported values for the Central massif granites as well as the Atlas domain granites in order to characterize the behaviour of the geochemical elements in the Moroccan granites.

3.3.2 The Moroccan Data

The geochemistry of twenty-seven samples from the Jebilet Massif and seventeen samples from the Rehamna Massif is presented and discussed in this section (see Figures 2.1, 2.3, 2.5 and 2.7 for sample locations). This includes eight samples from the Tabouchennt-Bamega Pluton (TBP) and nineteen are from the Oulad Ouaslam Batholith (OOB) of the Jebilet Massif, and fourteen samples from the Sebt de Brikiine batholith (SDB) and three from the Ajar El Bark stock (AEB) of the Rehamna Massif. Samples were analysed for major and trace element (Ba, Rb, Sr, Y, Zr, Nb, Th, Pb, Ga, Zn, Cu, Ni, V, Cr) content by X-ray fluorescence. Four samples from the Oulad Ouaslam Batholith, three from the Tabouchennt-Bamega Pluton, four from the Sebt De Brikiine batholith and 2 from the Ajar El Bark stock were analysed by INAA for REE (Ce, Nd, Sm, Eu, Tb, Yb, Lu) content. The precision and accuracy of the analytical techniques are discussed in Appendix B.

Additional Moroccan data from the Central and Tichka Massifs were collected from various bibliographic sources. A complete listing of the data is given in Appendix D.

3.3.3 Major and Trace Elements

The minimum, maximum, mean and standard deviation values for the Jebilet, Rehamna, Central and Tichka granites are compared in Table 3.1. Some differences between the massifs are evident in Table 3.2. Particularly averages for the Rehamna granites contrast clearly with those of the other massifs, markably in its higher SiO_2, and Y values as well as its lower TiO_2, Al_2O_3, Fe_2O_{3t}, MgO, CaO, Ba, Sr and Nb values. A spidergram of the Central, Rehamna and Jebilet granites is presented in Figure 3.4. The Tichka granite could not be included because of the limited amount of data. The ranges for each massif were determined by calculating the mean $\pm$ 1 from Table 3.2. The contrast between the Rehamna and Jebilet granites is evident in this diagram. The trace elements of the Rehamna granites display more variation than the Jebilet granites, however the Central massif show the most variation with values covering the range defined by the two other massifs.

3.3.4 Rare Earth Elements

Rare earth element analysis performed on four samples from the OOB and three from the TBP, four from the SDB and two from the AEB are plotted onto a chondrite normalized diagram in Figure 3.5.

The Jebilet and Rehamna granites display similar REE patterns, and differ only in their Eu values which is probably related to the crystallisation of feldspars. As for the trace element data the REE patterns for the Rehamna show greater variation than the Jebilet granites. The limited amount of data make the characterization of Rare Earths within the Moroccan granites difficult.

3.3.5 Rb-Sr and Sm-Nd Isotopes

Rb-Sr and Sm-Nd isotopic values as determined by Mrini (1985) and Tisserant (1977) are plotted on Figure 3.6. Values were plotted by

Table 3.2. Basic statistics for major and trace element data from the Central, Rehamna, Jebilet and Tichka Massifs of Morocco.

	Central	Rehamna	Jebilet	Tichka	Central	Rehamna	Jebilet	Tichka
	SiO_2				TiO_2			
Minimum	60.48	74.74	62.80	67.32	0.01	0.02	0.06	0.14
Maximum	77.61	77.93	75.66	75.08	1.13	0.20	0.96	0.51
Mean	71.89	76.58	68.25	70.41	0.25	0.09	0.58	0.40
St.Deviation	3.30	0.90	2.67	2.60	0.22	0.05	0.17	0.14
Number	216	17	31	6	204	17	31	6
	Al_2O_3				Fe_2O_{3t}			
Minimum	12.19	12.25	13.45	13.14	0.10	0.40	0.42	0.95
Maximum	18.90	13.56	16.55	15.34	6.55	1.49	6.59	3.15
Mean	15.05	12.80	15.35	14.39	1.88	0.99	4.13	2.27
St.Deviation	1.16	0.39	0.80	0.81	1.24	0.29	1.11	0.77
Number	216	17	31	6	216	17	31	6
	MnO				MgO			
Minimum	0.01	0.01	0.02	0.02	0.01	0.01	0.06	0.80
Maximum	1.07	0.04	0.10	0.10	3.17	0.21	2.34	2.14
Mean	0.05	0.02	0.06	0.06	0.63	0.06	1.24	1.56
St.Deviation	0.08	0.01	0.02	0.03	0.65	0.06	0.52	0.46
Number	183	17	31	6	199	17	31	6
	CaO				Na_2O			
Minimum	0.01	0.33	0.37	0.75	0.20	3.05	1.80	3.39
Maximum	4.49	1.92	3.37	2.16	4.80	4.23	3.86	4.72
Mean	1.04	0.75	1.90	1.65	3.16	3.64	2.86	4.32
St.Deviation	0.93	0.41	0.63	0.56	0.63	0.29	0.36	0.48
Number	203	17	31	6	216	17	31	6
	K_2O				P_2O_5			
Minimum	1.15	4.32	3.65	3.19	0.02	0.01	0.01	0.10
Maximum	7.32	5.19	6.06	5.00	1.45	0.10	0.46	0.15
Mean	4.43	4.79	4.47	3.71	0.30	0.03	0.17	0.13
St.Deviation	0.94	0.21	0.61	0.68	0.27	0.02	0.07	0.01
Number	216	17	31	6	69	17	31	5

Table 3.2 (cont.). Basic statistics for major and trace element data from the Central, Rehamna, Jebilet and Tichka Massifs of Morocco.

	Central	Rehamna	Jebilet	Tichka	Central	Rehamna	Jebilet	Tichka
	A/CNK				**D.I.**			
Minimum	0.94	0.86	1.03	0.99	61.70	92.96	65.69	79.01
Maximum	2.83	1.13	1.41	1.06	96.60	96.93	94.95	90.04
Mean	1.30	1.02	1.19	1.02	87.22	94.83	79.50	83.33
St.Deviation	0.20	0.07	0.08	0.03	6.91	1.22	5.87	3.97
Number	216	17	31	6	216	17	31	6
	Ba				**Rb**			
Minimum	7	4	217	-	5	150	130	-
Maximum	1540	234	778	-	1473	368	286	-
Mean	317	91	545	-	345	248	193	-
St.Deviation	244	75	121	-	214	68	46	-
Number	190	17	27	-	195	17	27	-
	Sr				**Y**			
Minimum	10	4	74	-	8	19	17	-
Maximum	681	75	631	-	51	89	46	-
Mean	150	28	208	-	25	40	35	-
St.Deviation	142	22	124	-	12	20	7	-
Number	192	17	27	-	27	17	27	-
	Zr				**Nb**			
Minimum	32	43	40	-	7	12	6	-
Maximum	271	138	238	-	37	67	17	-
Mean	135	94	196	-	17	31	14	-
St.Deviation	75	26	39	-	7	13	2	-
Number	27	17	27	-	27	17	27	-
	Th				**Pb**			
Minimum	1.0	15.0	2.0	-	2	8	18	-
Maximum	38.0	55.0	27.0	-	37	28	72	-
Mean	12.8	38.6	15.8	-	22	18	26	-
St.Deviation	9.3	10.4	5.9	-	8	6	11	-
Number	27	17	27	-	27	17	27	-

Table 3.2 (cont.). Basic statistics for major and trace element data from the Central, Rehamna, Jebilet and Tichka Massifs of Morocco.

	Central	Rehamna	Jebilet	Tichka	Central	Rehamna	Jebilet	Tichka
	Ga				**Zn**			
Minimum	16	17	15	-	1	11	15	-
Maximum	36	23	23	-	122	27	157	-
Mean	23	19	20	-	54	17	61	-
St.Deviation	5	2	2	-	23	4	28	-
Number	27	17	27	-	137	17	27	-
	Cu				**Ni**			
Minimum	1	1	3	-	4	11	17	-
Maximum	112	9	23	-	94	47	32	-
Mean	11	3	12	-	17	27	27	-
St.Deviation	15	3	6	-	14	11	4	-
Number	121	11	26	-	65	17	27	-
	V				**Cr**			
Minimum	1	1	1	-	6	3	10	-
Maximum	209	11	117	-	265	22	60	-
Mean	42	4	68	-	34	8	41	-
St.Deviation	44	3	21	-	43	4	12	-
Number	82	15	27	-	65	17	27	-
	Co				**Li**			
Minimum	10	-	-	-	23	-	-	-
Maximum	62	-	-	-	1451	-	-	-
Mean	12	-	-	-	140	-	-	-
St.Deviation	9	-	-	-	161	-	-	-
Number	38	-	-	-	130	-	-	-
	B				**F**			
Minimum	20	-	-	-	10	-	-	-
Maximum	26	-	-	-	1000	-	-	-
Mean	21	-	-	-	337	-	-	-
St.Deviation	2	-	-	-	260	-	-	-
Number	16	-	-	-	16	-	-	-

Table 3.2 (cont.). Basic statistics for major and trace element data from the Central, Rehamna, Jebilet and Tichka Massifs of Morocco.

	Central	Rehamna	Jebilet	Tichka	Central	Rehamna	Jebilet	Tichka
	U				W			
Minimum	1.0	-	-	-	0.3	-	-	-
Maximum	3.1	-	-	-	104.0	-	-	-
Mean	2.2	-	-	-	16.8	-	-	-
St.Deviation	0.7	-	-	-	22.9	-	-	-
Number	9	-	-	-	27	-	-	-
	Sn				Mo			
Minimum	2	-	-	-	0.1	-	-	-
Maximum	930	-	-	-	0.5	-	-	-
Mean	30	-	-	-	0.2	-	-	-
St.Deviation	99	-	-	-	0.1	-	-	-
Number	87	-	-	-	16	-	-	-

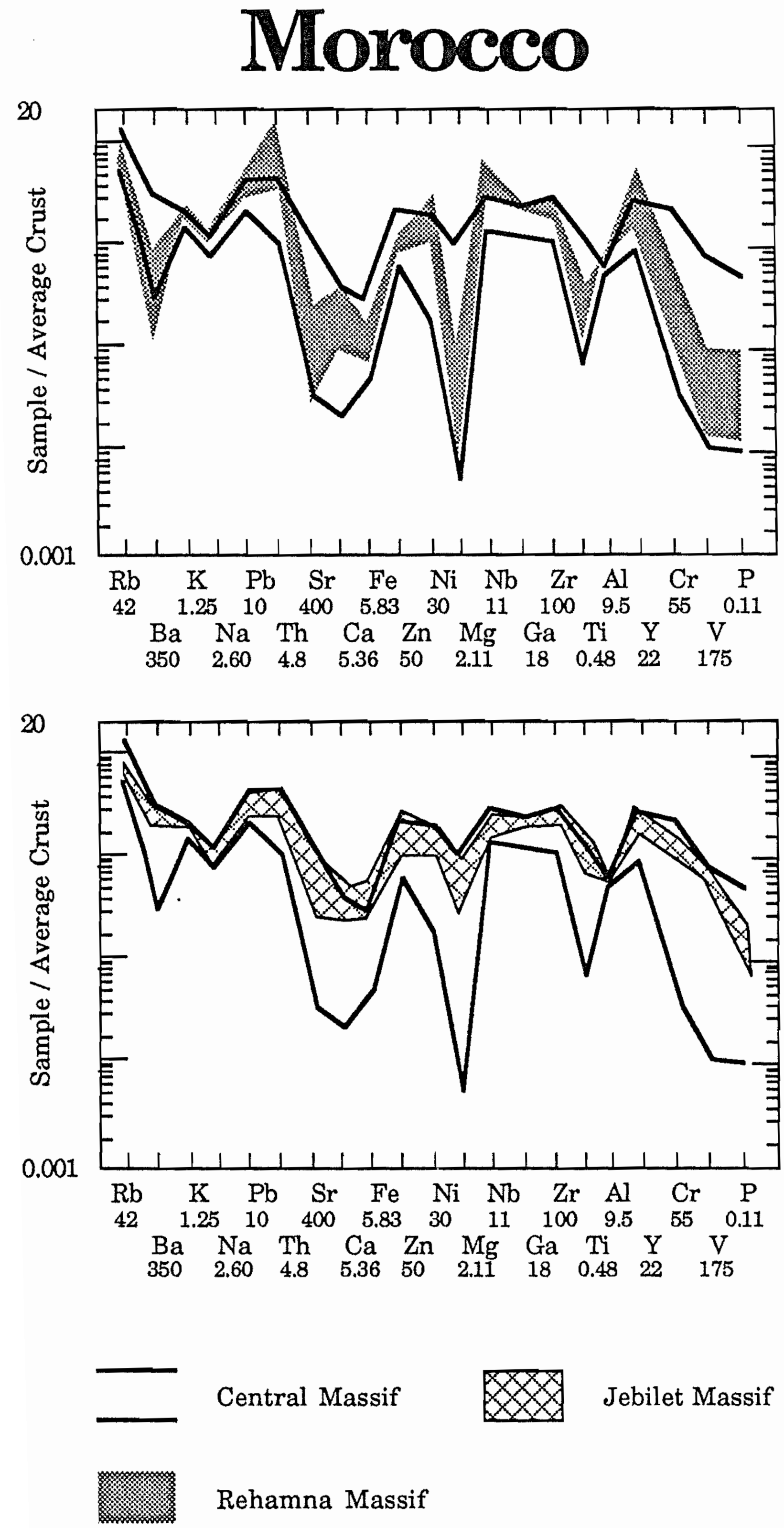


Figure 3.4. Spider diagram comparing geochemical populations of the Jebilet, Rehamna and Central Massifs. Each range represents the mean $\pm$ 1σ.

Jebilet and Rehamna Granites

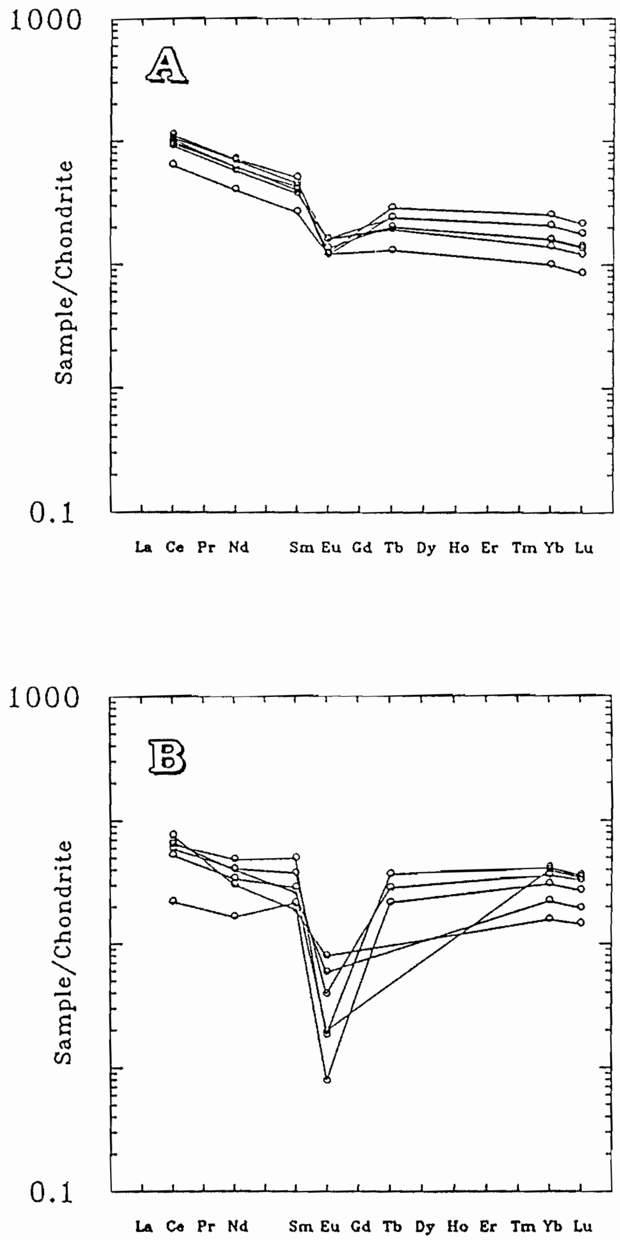


Figure 3.5. REE plots comparing the Jebilet (A) and Rehamna (B) granites of Morocco.

massif in which the southernmost massif is found at the bottom of the diagram and the northernmost at the top. A broad regional pattern is evident in the Rb-Sr isotopes of Figure 3.6a. Mantle values were detected in the Tichka massif and the Azegour pluton displays low values which are almost mantle-like. Further north in the Jebilet and Rehamna massifs, intermediate values become apparent. In the Central massif and the Middle Atlas (which are at similar latitudes) distinct crustal values and intermediate values are measured.

This regional variation in the Rb-Sr isotopes is confirmed by the Sm-Nd isotopes (Figure 3.6b), with higher values in the south and lower, crustal values in the north.

The geochronological data for the Moroccan granites is shown in Figure 3.6c. Provided that the age obtained for the Azegour pluton is correct, there does not seem to be a relationship between the age of the pluton and the initial isotopic ratios. This may indicate that the variation in the isotopes did not occur through time, but rather geographically. A bimodality in the magmatism (mantle and crustal values) is suggested by the isotopic data. A dominant mantle component to the south probably mixed with a crustal component in the intermediate plutons, while the northern plutons show less influence by a mantle component.

3.4 Comparing the Nova Scotian and Moroccan Granites

3.4.1 Introduction

In this section the geochemical data from Nova Scotia and Morocco are compared in order to determine the degree of similarity between the regions. The Nova Scotian granites are considered as one coherent population in this section, that is no distinction is made between the northern and southern granites of Nova Scotia. Equally all of the Massifs of Morocco are considered to be one population.

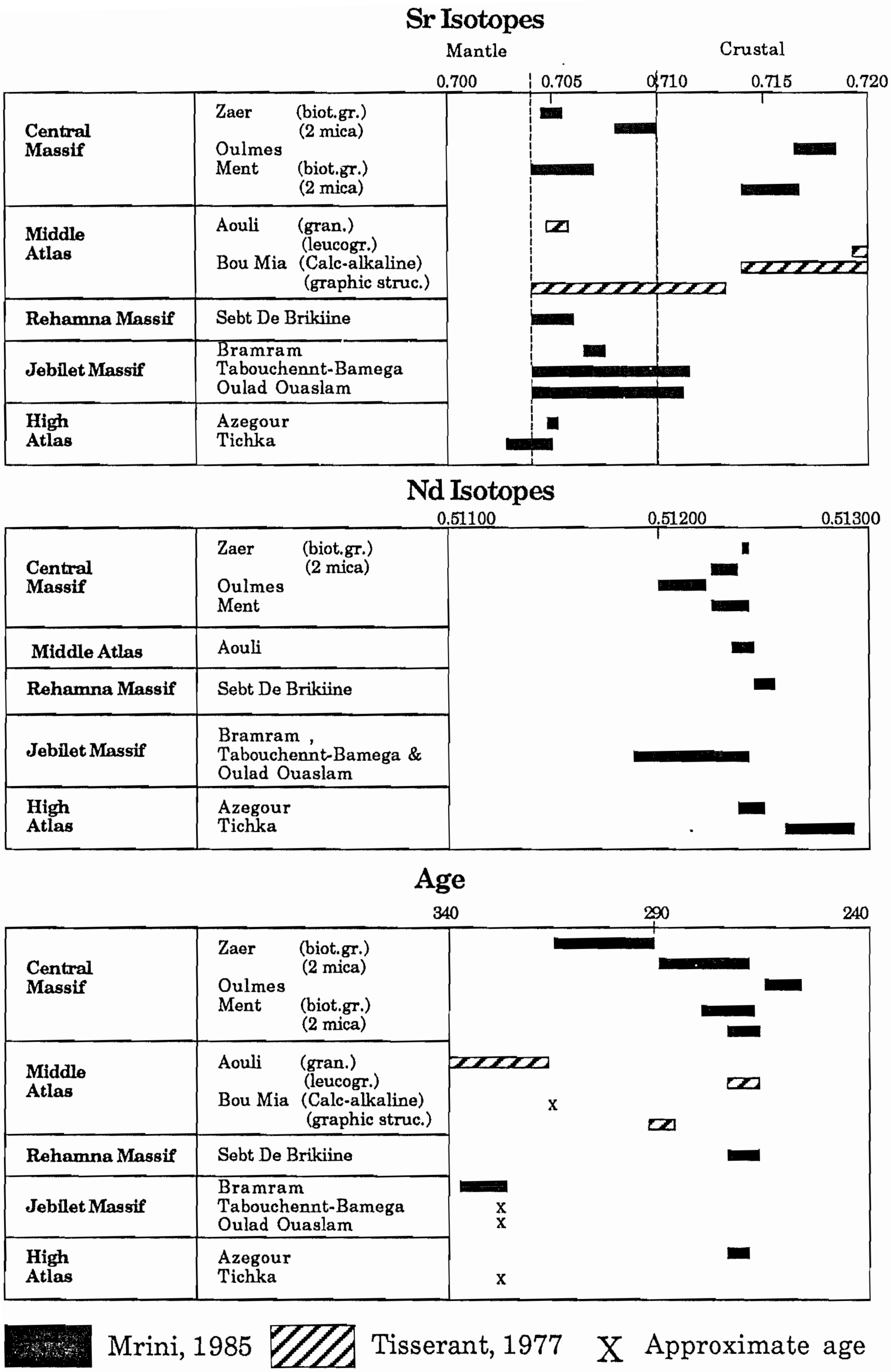


Figure 3.6. Sr, Nd initial isotopic ratios and ages for the Moroccan granites data from Mrini, 1985 and Tisserant, 1977.

3.4.2 Major and Trace elements

The minimum, maximum, mean and standard deviation of values from the Nova Scotian and Moroccan granites are compared in Table 3.3. Frequency distributions are shown in Figure 3.7. Generally values for both areas display a considerable amount of overlap. Some minor differences are evident between the two areas particularly in the higher CaO, Sr, and V values in Morocco. As for the northern and southern granites of Nova Scotia, statistical analysis of the means was not pursued because of the large variances measured in the different populations. The degree of similarity between the two areas is also evident in the spidergram of Figure 3.8, in which the mean $\pm$ 1 of each population is presented.

3.4.3 Rare Earth Elements

All available rare earth data from Nova Scotia and Morocco are plotted onto Figure 3.9. Because each population includes so few plutons it is doubtful that the sample populations are truly representative. Therefore very little can be said about Figure 3.9 except that both sample populations present some overlap in their values.

3.4.4 Isotopes

Nd and Sr isotopic data from Nova Scotia and Morocco are presented in Figure 3.10. Again interpretations are constrained by the unrepresentative nature of the data, in this case Nova Scotia from which Nd isotopic data is only available for the South Mountain batholith.

Data from Australia (McCulloch and Chappell, 1982), the Sierra Nevada Peninsular ranges (Allegre and Othman, 1980; DePaolo, 1980), the french Hercynian (Allegre and Othman, 1980), and the Caledonian

Table 3.3. Basic statistics for major and trace element data from Nova Scotia and Morocco.

	N.S.	Mor.	N.S.	Mor.	N.S.	Mor.	N.S.	Mor.
	SiO_2		TiO_2		Al_2O_3		Fe_2O_{3t}	
Minimum	59.75	60.48	0.02	0.01	11.39	12.19	0.17	0.10
Maximum	78.13	77.93	1.07	1.13	20.18	18.90	6.74	6.59
Mean	71.96	71.73	0.30	0.28	14.74	14.93	2.17	2.09
St.Deviation	3.20	3.55	0.21	0.24	1.16	1.22	1.29	1.41
Number	383	270	383	258	383	270	383	270
	MnO		MgO		CaO		Na_2O	
Minimum	0.01	0.01	0.02	0.01	0.19	0.01	1.52	0.20
Maximum	0.60	1.07	3.62	3.17	5.19	3.17	5.82	4.80
Mean	0.06	0.05	0.64	0.69	1.21	0.69	3.65	3.18
St.Deviation	0.05	0.07	0.61	0.67	0.99	0.67	0.52	0.63
Number	382	237	383	253	383	253	383	270
	K_2O		P_2O_5		A/CNK		D.I.	
Minimum	1.15	1.15	0.02	0.01	0.93	0.86	59.39	61.70
Maximum	6.40	7.32	0.87	1.45	1.46	2.83	96.69	96.93
Mean	4.07	4.44	0.23	0.22	1.18	1.27	87.00	86.73
St.Deviation	0.98	0.89	0.12	0.23	0.08	0.20	7.42	7.28
Number	383	270	383	122	383	270	383	270
	Ba		Rb		Sr		Y	
Minimum	2	4	36	5	2	4	3	8
Maximum	1200	1540	931	1473	720	1473	50	89
Mean	375	327	247	321	118	321	16	33
St.Deviation	262	245	154	202	112	202	8	14
Number	366	234	386	236	372	239	194	71
	Zr		Nb		Th		Pb	
Minimum	15	32	1	6	0.4	1.0	4	2
Maximum	389	271	31	67	44.0	55.0	74	72
Mean	105	148	12	19	8.7	20.1	22	22
St.Deviation	61	67	4	10	7.2	13.4	9	9
Number	328	71	248	71	272	71	256	71

N.S. = Nova Scotia Mor. = Morocco

Table 3.3 (cont.). Basic statistics for major and trace element data from Nova Scotia and Morocco.

	N.S.	Mor.	N.S.	Mor.	N.S.	Mor.	N.S.	Mor.
	Ga		Zn		Cu		Ni	
Minimum	12	15	5	1	1	1	1	4
Maximum	27	36	195	157	104	112	104	94
Mean	20	21	51	52	9	52	9	21
St.Deviation	3	4	22	25	11	25	11	13
Number	152	71	326	181	157	181	157	109
	V		Cr		Hf		Cs	
Minimum	1	1	2	3	1.4	-	5.0	-
Maximum	136	209	404	265	4.2	-	44.2	-
Mean	28	43	38	32	2.7	-	20.5	-
St.Deviation	30	41	43	26	0.8	-	10.5	-
Number	178	124	213	109	15	-	19	-
	Sc		Ta		Co		Li	
Minimum	1	-	0.7	-	1	10	19	23
Maximum	7	-	9.7	-	5	62	801	1451
Mean	5	-	5.2	-	2	12	140	140
St.Deviation	1	-	2.7	-	1	9	125	161
Number	26	-	15	-	27	38	214	130
	Be		B		F		Cl	
Minimum	0.5	-	3	20	60	10	50	-
Maximum	205.0	-	150	26	2400	1000	175	-
Mean	7.5	-	21	21	546	337	81	-
St.Deviation	17.7	-	17	2	334	260	62	-
Number	143	-	114	16	188	16	4	-
	U		W		Sn		Mo	
Minimum	0.8	1.0	1	0.3	1	1	0.6	0.1
Maximum	35.0	3.1	34	104.0	52	930	10.0	0.5
Mean	6.8	2.2	5	16.8	12	30	1.6	0.2
St.Deviation	6.0	0.7	6	22.9	11	99	0.1	0.1
Number	197	9	73	27	271	87	144	16

N.S. = Nova Scotia Mor. = Morocco

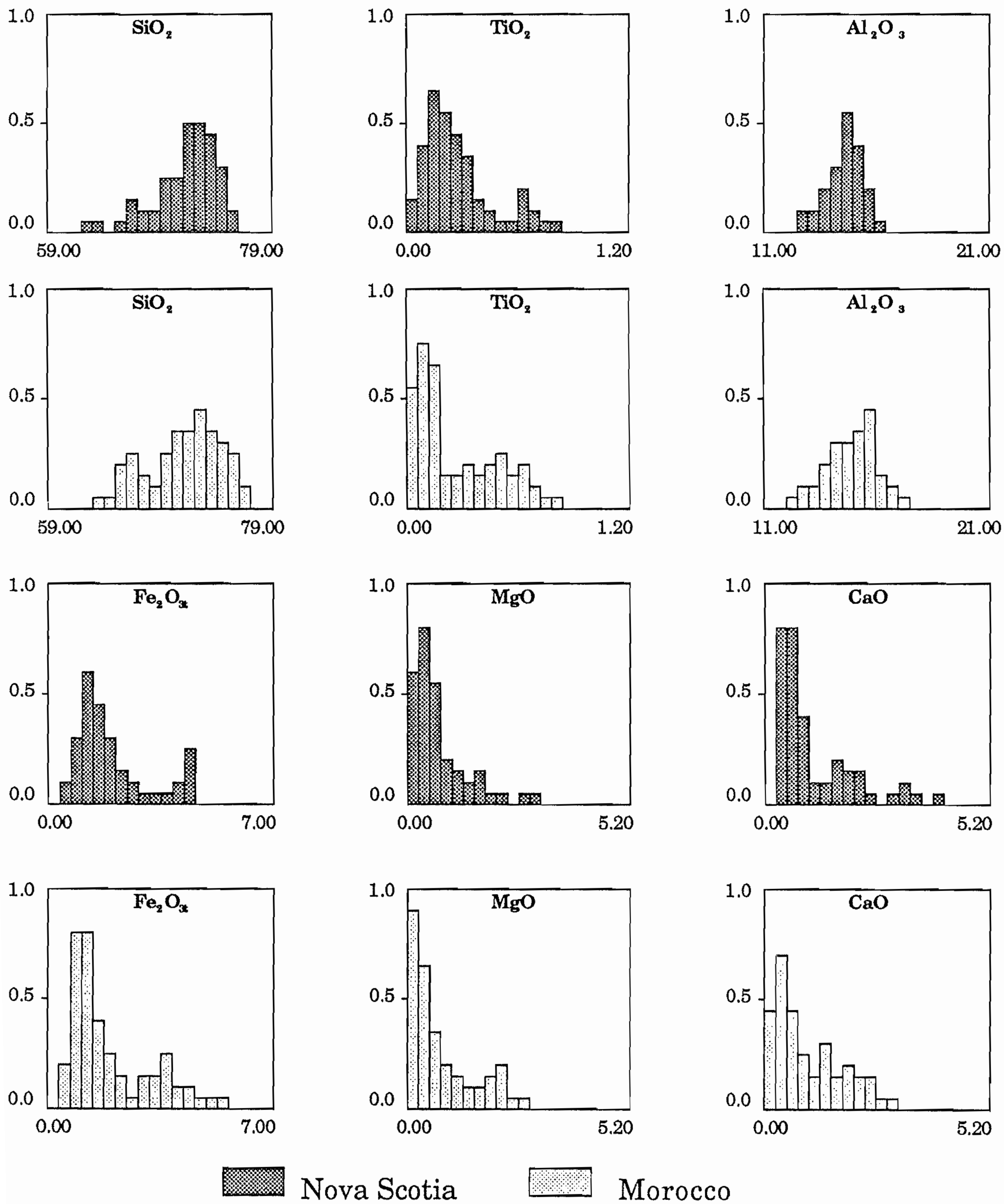


Figure 3.7. Frequency distributions of major and trace element data from Nova Scotia and Morocco.Major oxided in wt% , trace elements in ppm.

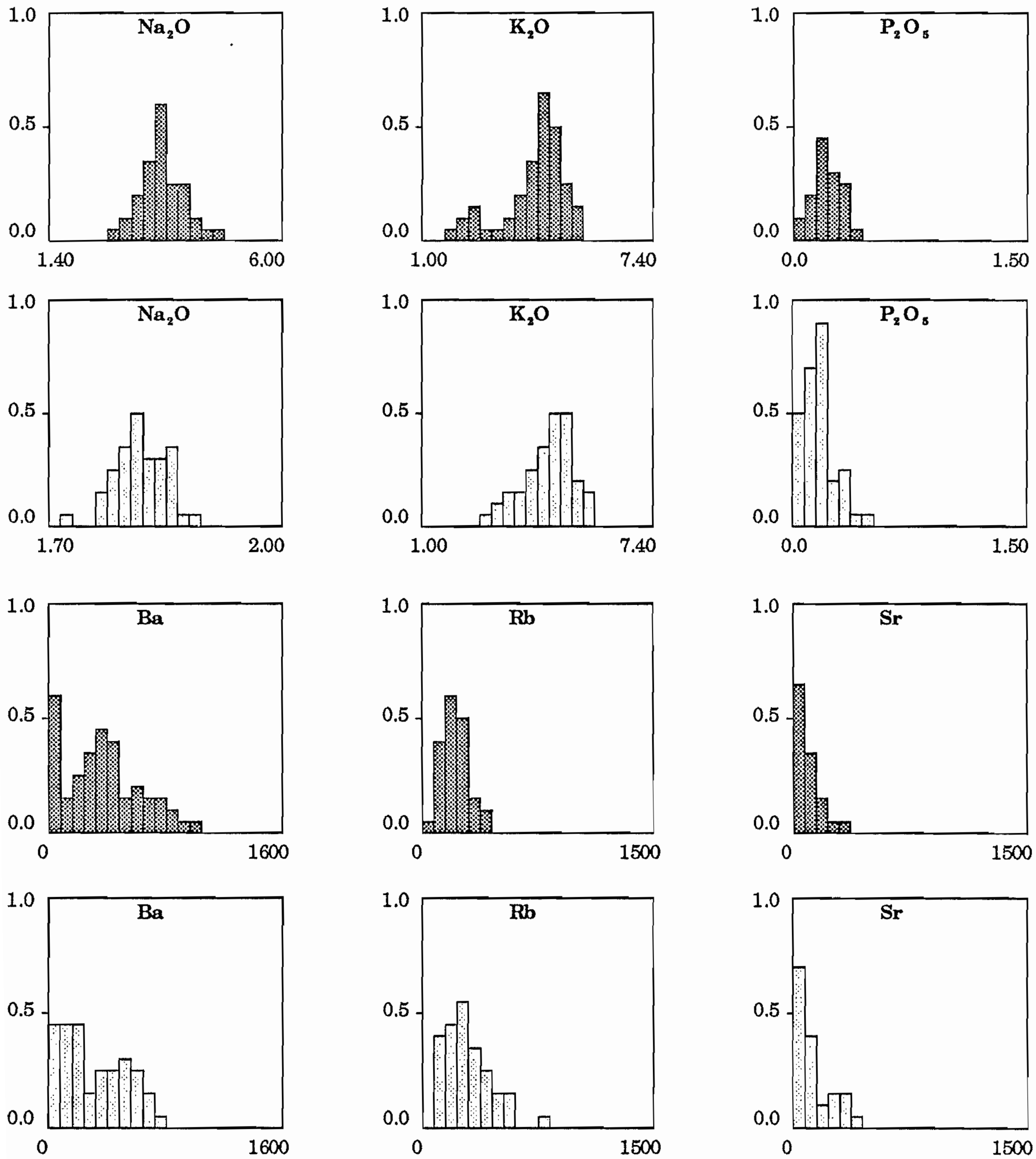


Figure 3.7 (cont.). Frequency distributions of major and trace element data from Nova Scotia and Morocco.

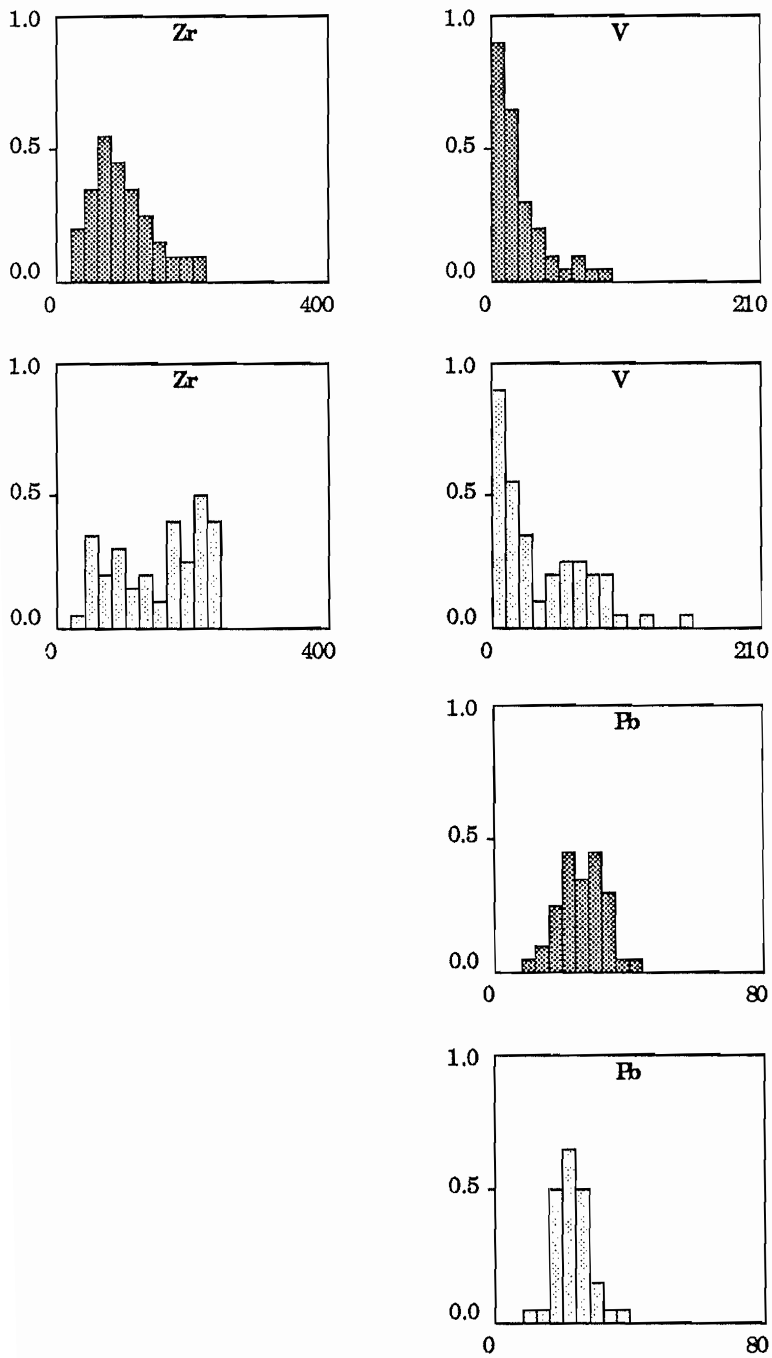


Figure 3.7 (cont.). Frequency distributions of major and trace element data from Nova Scotia and Morocco.

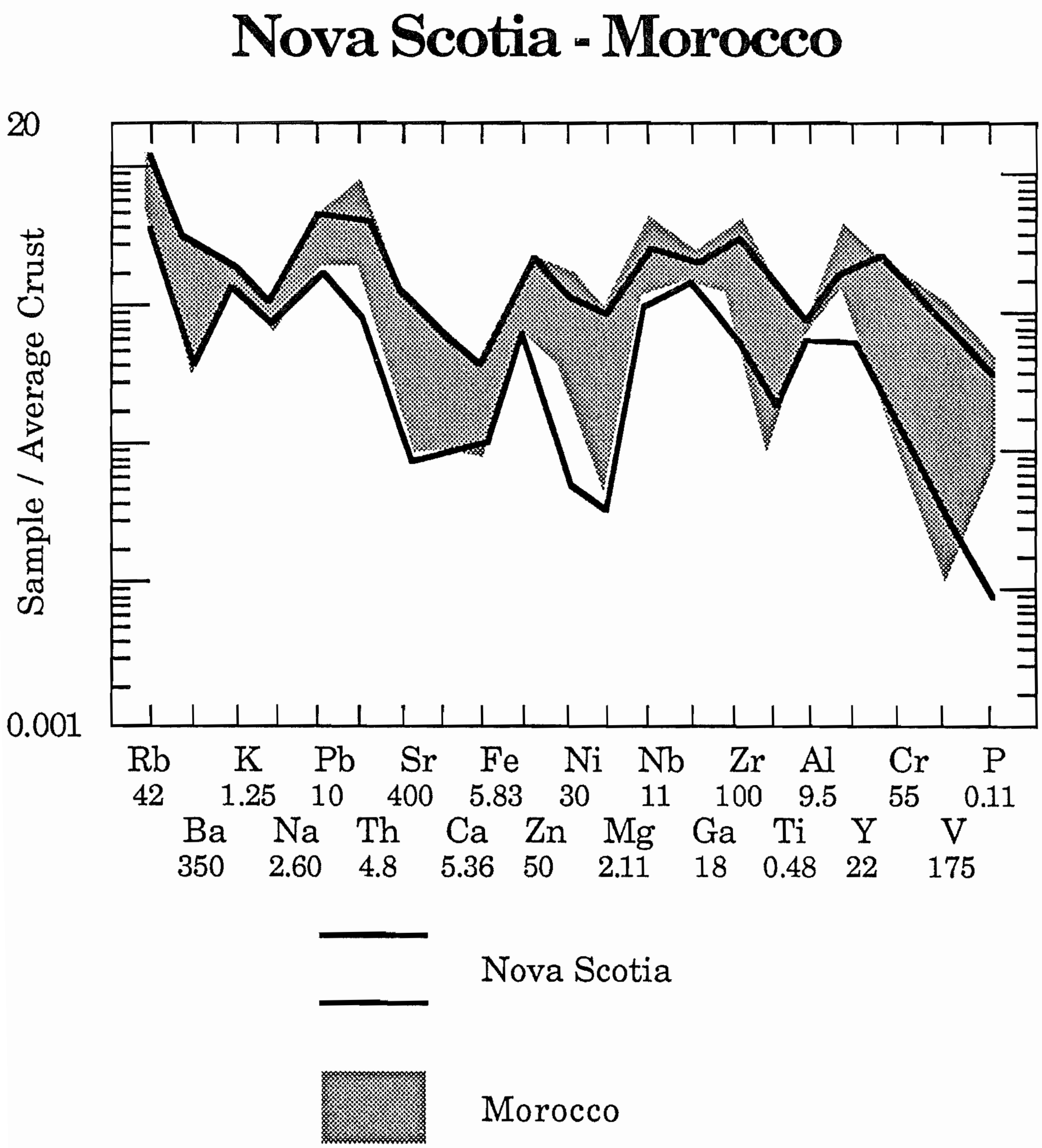


Figure 3.8. Spider diagram comparing geochemical populations of Nova Scotia and Morocco. Each range represents the mean $\pm$ 1σ .

Nova Scotia - Morocco

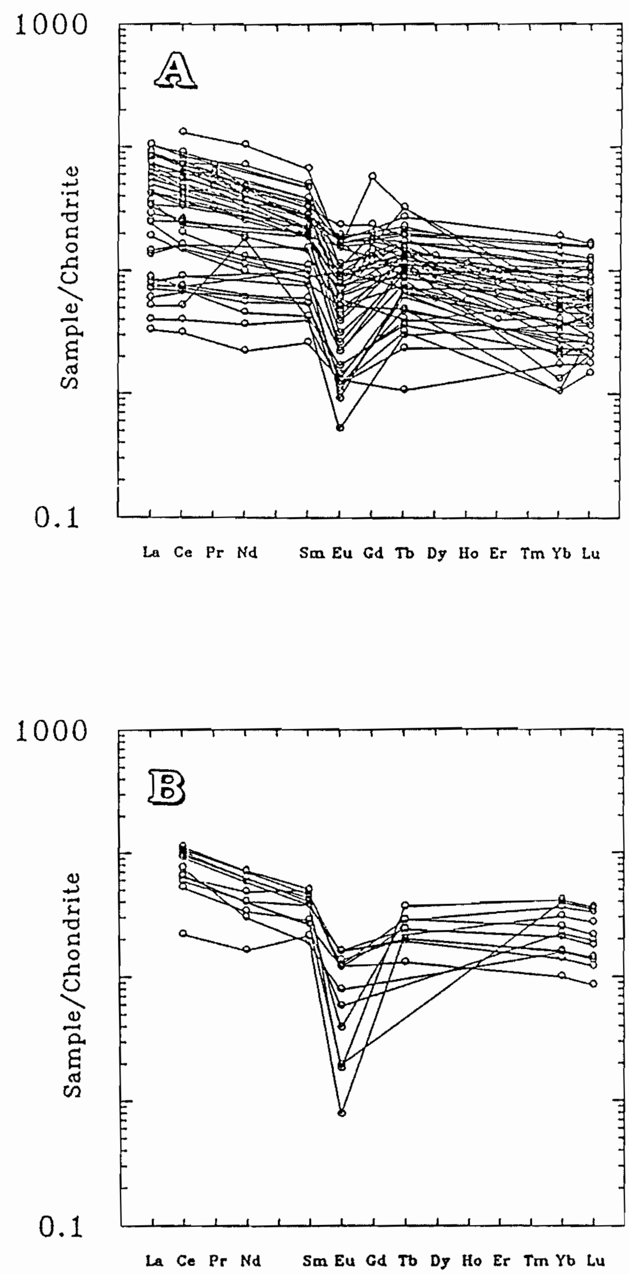


Figure 3.9. REE plots comparing geochemical populations of Nova Scotia (A) and Morocco (B).

Nd-Sr Isotopes (Morocco, Nova Scotia)

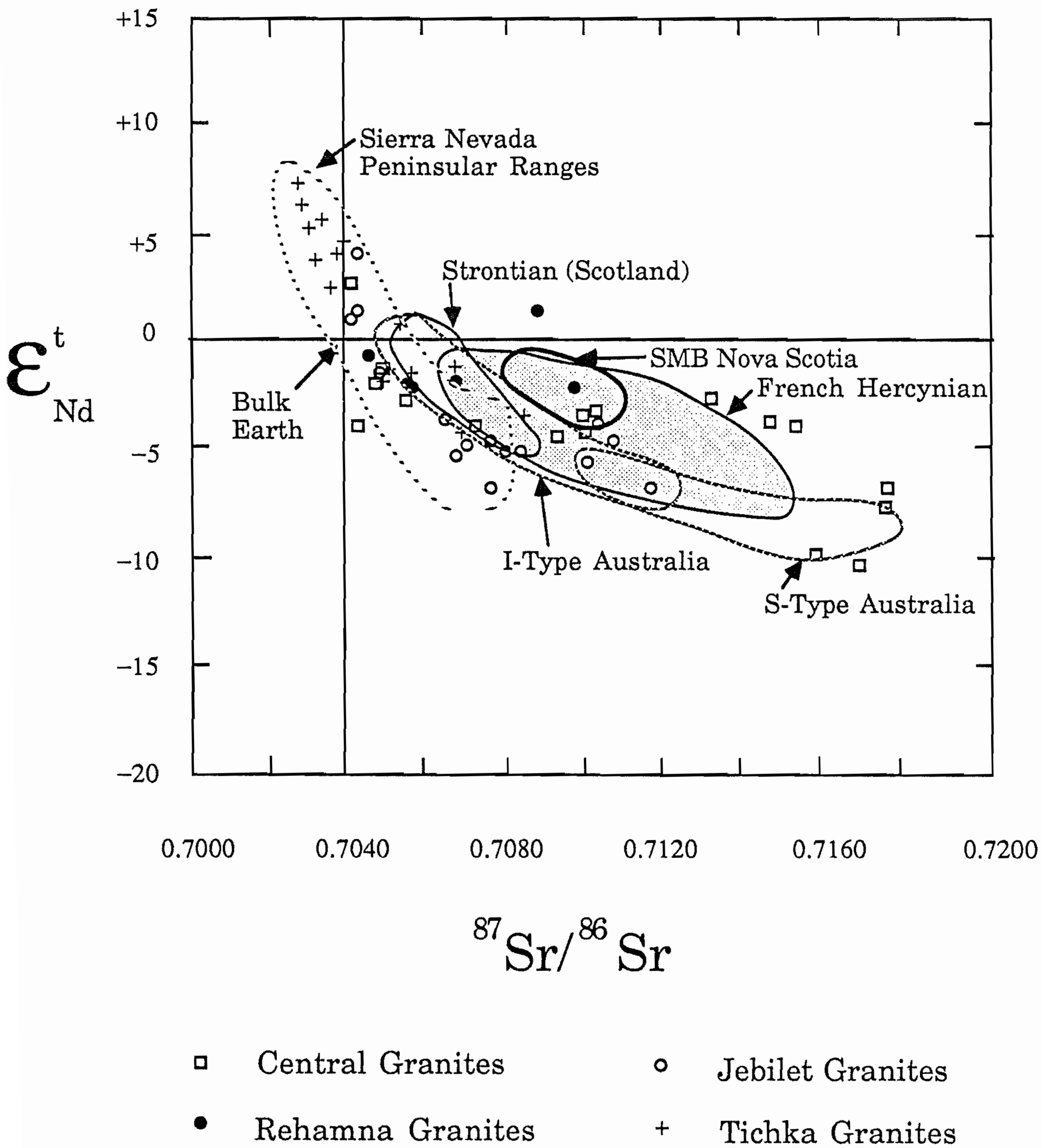


Figure 3.10. Plot comparing the initial Nd-Sr data from Morocco and Nova Scotia. See text for source references.

granites of Scotland (Hamilton et al., 1980) are included on Figure 3.10 for comparison.

Generally it can be said that the SMB is isotopically similar to the Central Massif of Morocco (particularly the Ment pluton), and to the French Hercynian granites. The SMB is definitely different from the Sierra Nevada Peninsular ranges granites. However without a more complete and representative database, similarity with the other granite groups cannot be ruled out on the basis of these isotopic values.

3.5 Summary

Comparison of the major, trace, rare earth and isotopic data using traditional methods of investigation has revealed that:

1- The geochemical populations of the northern and southern plutons of Nova Scotia, although apparently different, can not be clearly separated into two groups.

2- The Nova Scotian and Moroccan geochemical populations could not be separated and, in effect, appear indistinguishable.

3- In addition, limited Nd and Sr isotopic data also suggest some similarity between both areas.

CHAPTER 4

STATISTICAL INTERPRETATION OF GEOCHEMICAL DATA

4.1 Introduction

In petrology, petrogenetic interpretations of a geochemical data set are often made on the basis of correlations displayed within a subset of two or three of the variables. In recent years there has been a growing debate on the validity of some of these correlations, and the interpretations, because of the closed nature of geochemical data, i.e. each chemical analysis of a rock will sum to a constant (100%). Such a data set is said to be closed, and as such this problem has commonly been refered to as the closure or constant sum problem.

The problems outlined above can be overcome by using multivariate statistical techniques. However, to realize the full potential of these new techniques, many geologists will have to overcome their fears of both numbers and statistics, neither of which were part of a traditionally descriptive science. General concepts of statistics, and descriptions of multivariate techniques are presented in this chapter. In addition various theoretical data sets were generated in order to assess discriminant function analysis, a multivariate technique used for the modelling of the peraluminous granite database. Results and discussion on the data processing follow in Chapter 5.

4.2 Nature of the Geochemical Data

4.2.1 Introduction

In this section the nature of the geochemical data is examined from a mathematical point of view. Some of the basic principles relating to descriptions of populations are also reviewed.

4.2.2 Principal Types of Variables

Geological observations are made on definite quantitative variables that can be continuous or discrete (non-continuous), and predetermined or random (Le Maitre, 1982; Guillaume, 1977). Mathematically the values of predetermined variables are predictable and can often be defined by a function (eg. y=cos x). On the other hand, the variation of random variables is not predetermined, but can be described statistically (Guillaume, 1977). Discrete or non-continuous variables can only have certain values, for example the number of plutons in a massif. Continuous variables can, however, have any value. Geochemical events are continuous because they have an infinite number of possible outcomes. Although the range of possible outcomes is actually finite and may, in fact, be limited, the exact results that may be obtained remain unpredictable (Davis, 1973) (e.g major element data which is constrained to lie between the limits of 0 and 100). Geochemical events are, therefore, continuous random variables which may be described statistically, even though they may appear to be discrete variables when they are rounded to a specific number of decimal places because of analytical precision (eg. ppm and wt%). Geochemical data are also dimensionless, as they are expressed in weight per unit weight or volume per unit volume (e.g. wt% and ppm) (Le Maitre, 1982).

4.2.3 Specimen, Population and Sample

A specimen is the object on which the observations or measurements are made. A population is a set of measurements (not the objects) of a specific property made on a group of objects (Till, 1974). A population may be infinite or bounded. Geochemical populations can be considered infinite though they are in fact finite (Guillaume, 1977). For example, the alumina content of every feldspar in a granitic body can be thought of as an infinite population. Generally, it is not possible or practical to analyse every feldspar in a pluton, so we take a small sub-set of the population, a sample, to study its properties. Then we need to determine if the sample was well selected, and if its properties are representative of the population (Guillaume, 1977). The reader will note that the term sample is used to represent a number of observations from a population rather than one object as it is commonly used in geology. The term specimen will be used to designate the geologist's sample.

4.2.4 Specimen Selection Procedure

Ideally, to avoid bias, a sampling campaign should be carried out randomly, so that a priori each individual of a population has the same chance of being selected (Le Maitre,1982). Descriptions and discussion on appropriate selection procedures are beyond the scope of this thesis, therefore, the reader is referred for details to Le Maitre (1982), Guillaume (1977), Till (1974), and Davis (1972). It is, however, important that the reader realize that bias could be introduced at various stages of selection procedure: target outcrop, specimen location on the outcrop, hand specimen for analysis, portion of the crushed rock, and portion of powder for analyses (Le Maitre, 1982).

Therefore, bias could be introduced in up to 5 distinct stages of sampling, again assuming that the intent of the selection procedure was to collect an unbiased population. Clearly, the nature of some studies results in sample bias, such as those which include more evolved members of a granitic suite because of their association to mineralization. As some of the data were drawn from studies such as these (e.g. Charest, 1976; Farley, 1979; Giuliani, 1982) it is expected that the database will show some bias. It is not unreasonable to expect that all populations (Morocco, Iberia and Nova Scotia) used in this study may have been treated in a similar fashion, suggesting that such a bias may not be a problem.

4.2.5 Distribution

As part of a geochemical study we may want to examine the variation of silica within a granitic body. This variation in the silica content is a characteristic of the body, and is the final result of all physico-chemical processes which have affected the pluton throughout its evolutionary history. When we make a series of measurements on different hand specimens from the pluton, we are in effect determining the **distribution** of silica within the granitic body.

A histogram can be produced in order to visualize the frequency distribution of a measured property. Many different forms have been described by statisticians; however, only normal and lognormal distributions are observed in geochemical data (Le Maitre, 1982) (Figure 4.1). It is assumed that the reader is familiar with the different parameters used to described distributions (i.e. mean, maximum, standard deviation, variance). For details the reader is refered to Davis, (1973); Guillaume, (1982); Till, (1979); Le Maitre, (1982).

Frequency distributions may have either a symmetrical or asymmetrical distribution about a central value (Figure 4.2). Asymmetrical distributions are either positively or negatively skewed when tailing of the distribution are to the right and left respectively of the maximum value.

Depending on the number of observed maxima, a distribution may also be unimodal, bimodal or even trimodal (Figure 4.2). Generally, statisticians regard multimodality as representing more than one population; however, this is not always the case in geology. For example, in the silica distribution of a zoned granitic pluton, a bimodal distribution in an otherwise determined comagmatic sequence may be regarded as one population.

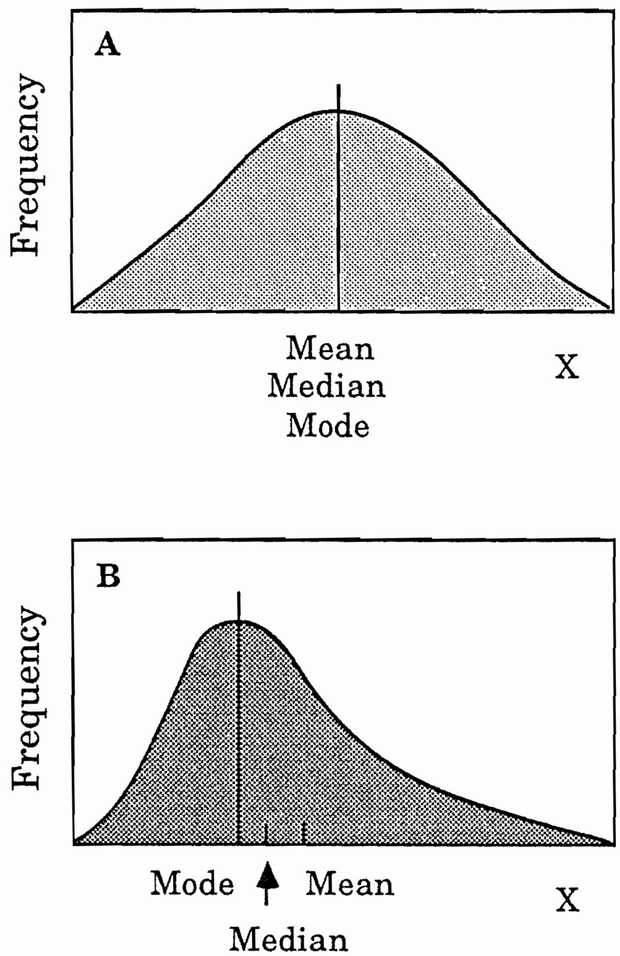


Figure 4.1. (A) Normal and (B) lognormal distribution curves.

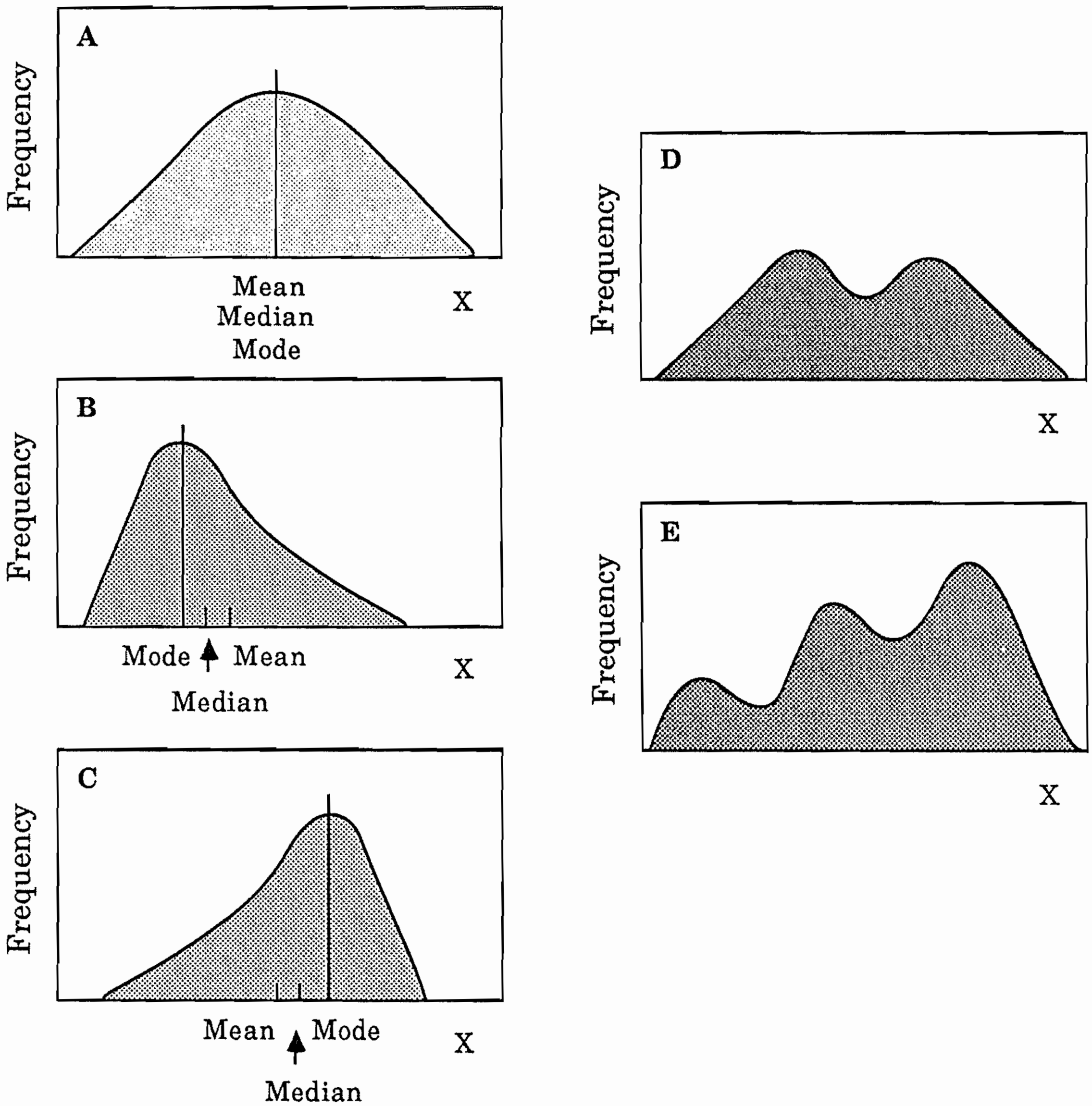


Figure 4.2. (A) Symmetrical (B) rightward skewed (C) leftward skewed (D) bimodal and (E) trimodal distributions.

Determining the distributions of all the variables is central to any study which attemps to utilize statistical techniques, as these are based on the normal distribution theory (Nie et al., 1975; Le Maitre, 1982). Transformations may be necessary if the data are not normally distributed. For example, trace element data which commonly display lognormal distributions may be made normal by effecting a log transformation, either as $z=\log(x)$ or $z=\log(x+w)$ where w is a constant. Transformations as they apply to the geochemical data used in this study will be discussed further in Section 4.4.2.

4.2.6 The Closure Problem

One of the fundamental problems plaguing geochemical data is that of the constant sum or closure. Simply stated, closure occurs when the sum of all components (variables) measured during the analysis of an object is constant. In such a case an increase in one component would result in the decrease of at least one other. Moreover, in a closed data set of 4 components ($X^{(d+1)}$), for example, only 3 components are necessary to determine the fourth, the remaining component being one minus the sum of the first three:

$$(X^{d+1} = 1\text{-}EX_i)$$

Individual components in such a data vector (analysis) cannot vary independently.

Many authors have analysed and discussed the effects of closure on a data set Chayes (1962), Chayes and Krustal (1966), Connor and Mossiman (1969), Chayes (1971), Aitchinson (1981), Aitchinson (1984a, 1984b), Butler and Woronow (1986). Summarized below are some of the problems as outlined by these authors.

To illustrate the problem from a petrological point of view the following example is considered. In a plot of MgO and SiO_2 values from a typical granitic pluton, the decrease in MgO with increasing SiO_2 might be interpreted three ways according to Butler and Woronow (1986): 1) some process such as fractional crystallization of biotite may account for the decrease in MgO and the increase in SiO_2 in the residual liquid; 2) the negative correlation could be interpreted as purely a numeric response, in which a decrease in one component induces an increase in the other components, because of the constant sum restriction; 3) a combination of both one and two, with some physico-chemical response and a numerical response being responsible for the variation.

The effects of closure are demonstrated using a randomly-generated, open data set (or basis of Aitchinson (1986)), which was then closed by recalculating each row (analysis) to the sum of 100 (or composition of Aitchinson (1986)). Statistical descriptors (means, variances, and correlation coefficients) were also computed and are presented in Figure 4.3 (Data from Butler and Woronow, 1986).

The following observations can be made: The rank order for sample means are $B<A<C$ in the basis and $B<C<A$ in the composition; percentage formations have reversed the rank order of variables A and C showing the largest sample means; the rank order for the variances of the basis ($A<B<C$) and the composition ($B<C<A$) have also been modified.

Percentage formations will generally result in either expansion or contraction of the variability of the components when compared with their original form in the basis. Similarly, the skewness may be modified by percentage manipulations with, for example, positively skewed distributions made to be symmetrical or even negatively skewed (Chayes, 1972).

Correlation coefficients may also be adversely affected by percentage formation. For example, two basis components (variables) which were originally noncorrelated may become correlated in the composition. Generally, basis components with large variances will show a negative correlation for the composition, and basis components with small variances will have positive correlations. If a pair of variables in the basis is correlated (not independent) there will still

BASIS / COMPOSITION

RAW DATA

Basis

	A	B	C	Sum
1	3.5	2.0	1.3	6.8
2	4.7	0.8	1.2	6.7
3	2.3	4.7	8.9	15.9

Composition

	A	B	C	Sum
1	51.47	29.41	19.12	100.00
2	70.15	11.94	17.91	100.00
3	14.47	27.56	55.97	100.00

BASIC STATISTICS

Basis

	A	B	C
Minimum	2.3	0.8	1.2
Maximum	4.7	4.7	8.9
Mean	3.5	2.5	3.8
Variance	1.44	3.99	19.51

Composition

	A	B	C
Minimum	14.47	11.94	17.91
Maximum	70.15	29.56	55.97
Mean	45.36	23.64	31.00
Variance	830.16	102.62	468.14

CORRELATION COEFFICIENTS

Basis

	A	B
B	-0.976	
C	-0.872	0.957

Composition

	A	B
B	-0.762	
C	-0.953	0.530

Figure 4.3. Basic statistics and Pearson correlation coefficients for Basis and Composition (Data from Butler and Woronow, 1986).

be some change in the value of the correlation coefficients as a result of percentage formation. In the case of basis variables with large variances, the correlation coefficients are expected to change in the negative direction (i.e. towards the -1.0 value).

Correlation coefficients of Figure 4.3 show significant variations from basis to composition, with shifting occurring towards more negative values.

Aitchinson (1981,1982) suggested two non-linear transformations which would essentially allow us to circumvent the closure problem

1) the log ratio transformation
   where $Y_i = \log(X_i/X_j)$ with $i=1,2....D$

2) the log centering transformation
   where $Z_i = \log(X_i) - g(X)$ with $i=1,2....D$

   (g(X) the geometric mean is the sum of the logarithms of the components in an analysis divided by the number of components in the analysis.)

Both these transformations were applied to the basis and compositional data from Figure 4.3, and the results are given in Figure 4.4. The basis and composition for each separate transformation have matrices of equal value, suggesting that these transformations may be a solution in the analysis of compositions such as geochemical data.

In further analysis of these methods some drawbacks become apparent. For instance in the log centering tranformation each individual case will sum to the constant 0, essentially recreating closure. The question is how useful is a transformation which eliminates closure to the constant (1) to create closure to the constant (0). Should another transformation be effected to eliminate

BASIS **COMPOSITION**

LOG CENTER

	A	B	C
1	0.517	-0.043	-0.474
2	1.045	-0.725	-0.320
3	-0.689	0.025	0.664

	A	B	C
1	0.517	-0.043	-0.474
2	1.045	-0.725	-0.320
3	-0.689	0.025	0.664

LOG RATIO

	A/C	B/C
1	0.430	0.187
2	0.593	-0.176
3	0.949	-0.277

	A/C	B/C
1	0.430	0.187
2	0.593	-0.176
3	0.949	-0.277

Figure 4.4. Log center and log ratio transformation applied to the basis and compositional data of Figure 4.3.

the second closure problem (this is of course ridiculous), or is it one at all? This question remains unanswered in the literature.

The second method, the log ratio transformation also presents a problem, namely the fact that when we divide a component (X_i) by another component (X_j) variability in the X_i/X_j ratio may occur. Let us consider the following example of two compositions:

Component	A	B	C	SUM
Case 1	.30	.60	.10	1
Case 2	.30	.25	.45	1

after transformation become:

Component	A/B	log A/B	log A/C
Case 1	0.5	-0.693	1.098
Case 2	1.2	0.182	-0.405

Such a transformation is highly dependent on the denominator selected, and the question arises as to which denominator is the most appropriate, in order to approximate the interrelationships displayed in the original <u>unknown</u> basis. This question cannot yet be answered.

Although analysis of the data now appear possible using the log ratio and log centering transformation, it is still unclear whether or not such transformations represent a final solution to the closure problem. The problem of proving variable independence remains. A procedure to test for independence has been suggested by Aitchinson (1984). Although this procedure represents an interesting contribution towards solving the problem, much remains to be done, and further consideration was deemed beyond the scope of this thesis.

4.2.7 Graphical Representation of the Geochemical Data

In their studies of geochemical data, petrologists commonly resort to the use of graphical representations to portray the quantitative relationships within their data sets. This stems from the belief that graphical representations will promote better comprehension of the interrelationships between variables. However, these relationships may be adversely modified by the manipulations which we effect in our graphical representations. These distortions of the data may result in trends which are more numerical than petrogenetic in origin. The advantages and disadvantages of plotting geochemical data using binary and ternary diagrams are reviewed briefly in this section.

4.2.7.2 Binary Diagrams

Bivariate plots provide information on the interrelationships between only two components, and to rely on these partial analyses of a complete data set to make petrological interpretations may be misleading (Chayes, 1962; Baker, 1978; Butler, 1979; Aitchinson, 1984a, 1984b, 1984c). (See discussion below in Section 4.3.1).

Ratios in scatter diagrams are also commonly used in geology. In a study of such diagrams Skala (1979) found that in some circumstances two distinct populations may appear as a single highly correlated population by applying the appropriate ratios, and lead to possible misinterpretation of the data.

4.2.7.1 Ternary Diagrams

A common misconception in petrology is that ternary diagrams are more revealing than binary representations because they allow the user to illustrate the variation of more components in a given diagram. Such a diagram may be more misleading than useful because of the percentage transformation which we must effect in order to plot the data onto these triangular diagrams.

A great deal of variation in the means, variances and correlation coefficients is expected in the closing of the subset of 3 components used in a ternary plot. These changes in mean, variance and correlation values will be reflected in the distribution of sample points in a ternary plot (Skala, 1979; Butler, 1979). In order to ensure that no unreasonable amount of distortion is created as a result of plotting the data onto these diagrams, descriptors of variables (particularly correlation coefficients) before and after the transformations should accompany ternary diagrams when they are used to present the data. Perhaps instead of the ternary diagrams geologists should be moving towards three dimensional plots for these components, aided by computer graphics.

Suffice it to say that the solution appears to lie in the cautious application of the methods mentioned above in conjunction with multivariate statistical methods, as will be demonstrated below.

4.3 Multiple Discriminant Analysis

4.3.1 Introduction

Geologists have always preferred to use simple binary, ternary and tetrahedral diagrams to represent variations within their data set, no doubt related to the inability of the human eye to visualize more than three dimensions of space at one time. Commonly geologists will select from a compositon of major oxides certain variables such as CaO, Na_2O, K_2O and rescale to define a new subcomposition which can then be represented in a ternary CNK diagram (Aitchison, 1984a, 1984b, 1984c). The use of such subcompositional analyses has long been critized by geostatisticians (Chayes, 1962; Baker, 1978; Butler, 1979; Aitchison, 1984a, 1984b, 1984c) who contend that these partial analyses are subject to substantial loss of information which, in turn, may lead to serious misinterpretation of the data. Thus, a subcompositional analysis will retain only some of the variability displayed in the complete data set. If the goal during an analysis is to study the true variability of the data set, then new methods such as multivariate analysis need to be adopted which will allow the user to effect more realistic and objective analysis of the data set.

Having determined that multivariate analysis is a useful and even an essential part of a geochemical study an appropriate multivariate technique must then be selected to satisfy the goals set for the analysis. For instance, principal component analysis would allow the user to visualize the variation within a data set, a pluton for example. On the other hand multiple discriminant analysis could be computed to investigate the variation between known groups of data, two plutons for example. Cluster analysis allows the user to classify a set of data into separate, relatively distinct, and homogeneous groups (or clusters). A classification does not depend on any prior knowledge of grouping as does discrimination. Thus, clustering defines an unpredetermined number of "natural" groups, which may then be assigned a geological meaning (if any). Discriminant analysis, however, will produce a number of linear discriminant functions, which are dependent on the number of defined groups. Discriminant function analysis will enable the user to quantify the differences between predetermined groups and may also be used to allocate new specimens of unknown origin to one of the initially defined groups.

The main objective of this study is to investigate the variation between granitic rocks of various geographic regions and, therefore, multiple discriminant analysis was selected as an appropriate technique to achieve this goal.

4.3.2 Geometric Interpretation

The geometric interpretation of discriminant analysis using two groups, A and B is presented in Figure 4.5. Probability contours for both groups illustrate their distribution in bivariate space (Le Maitre, 1982). A discriminant analysis in this case would produce a single linear function, or eigenvector, normal to the "hyperplane" with

Discriminant function

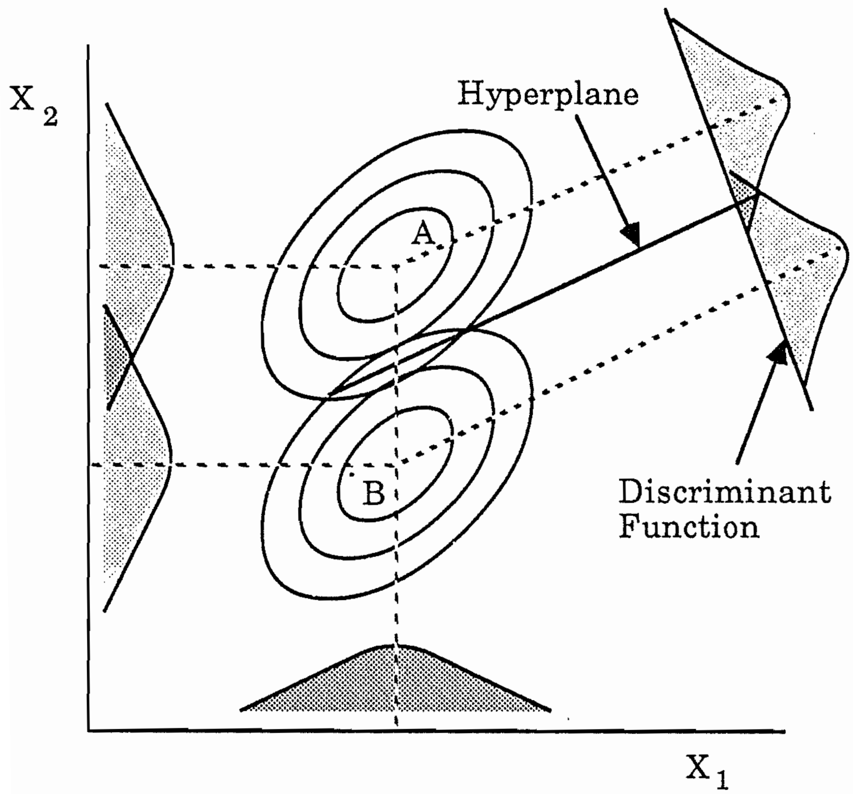


Figure 4.5. Geometric interpretation of discriminant function analysis. Dark shaded areas represent the amount of overlap between both populations (light shaded areas). Note that the best separation is obtained when the populations are projected onto the discriminant function. (From Le Maitre, 1982).

the largest ratio of between-group to within group variance. In other words, the hyperplane is the orientation which best separates the two groups (largest between-group variance) while simultaneously ensuring that each group has the least inflation (to minimize within group variance) (Davis, 1973).

The dark shaded areas in Figure 4.5 represent the amount of overlap between the two groups and serves as an indication of the efficiency of the separation. The best separation is obtained when the original data are projected onto the discriminant function. If the data were projected in any other direction, such as X_1 or X_2 then the amount of overlap would increase and the discriminating power would decrease.

Multiple discriminant analysis is based on the assumption that all variables are normally distributed, and that all groups have equal dispersion (variance-covariance) matrices i.e. all groups would have probability contours of similar shape and orientation (Le Maitre, 1982). Multiple discriminant analysis is believed to be "robust" (Nie et al., 1975) with respect to the form of the distribution, and therefore if departures from normality are small, they may be ignored. This problem will be evaluated in Section 4.3.6. On the other hand, unequal dispersion matrices may be of some consequence, as they theoretically cause the surface which best separates the groups to become curved. This may be solved either by using quadratic discriminant functions, or by transforming the data so that all dispersion matrices become similar.

To assume that "simple" linear discriminant function(s) will best separate groups of multivariate data is only a first approximation. Given the limited understanding of both the geochemical data and quadratic discriminant functions any further transformation of the data and use of more "sophisticated" methods might be premature.

Additional information on Discriminant function analysis is given in Appendix F.

4.3.3 The Curse of High Dimensionality

Statistical books in geology commonly mention a problem in multivariate statistics which they refer to as the curse of high dimensionality, and is related to the probability of separation of groups which increases with the number of variates.

To illustrate the curse of high dimensionality in discriminant analysis an example from Foley (1971) is discussed in this section. Two data sets of 28 variables and 110 cases were randomly generated with the following criterion: Each class has an equal **a priori** probability of occurence, the variables are independent and have uniform probability distributions in the range of 0 to 1.

In a first run 10 random specimens were randomly selected from each population (group) and the Fisher discriminant analysis was performed on the data. The data were projected onto the discriminant plane using the method described by Sammon (1970). The discriminant plane is, simply stated, an x-y plot of the two orthogonal vectors which maximize the discrimination between the two groups under different constraints. The x axis of the optimal plane is the Fisher discriminant vector and the y axis, while selected to insure maximum discrimination between the two groups, must also be orthogonal to the Fisher direction (Sammon, 1970). In Figure 4.6a a "perfect" separation between the two groups is evident. When all 110 samples are used in a second run (Figure 4.6b) discrimination between the two classes is not possible. This example suggests that if too few specimens are used in an analysis, then the discriminant function may tend to over separate groups (Foley, 1971; Howarth, 1983). This is the curse of high dimensionality.

The Curse of High Dimensionality

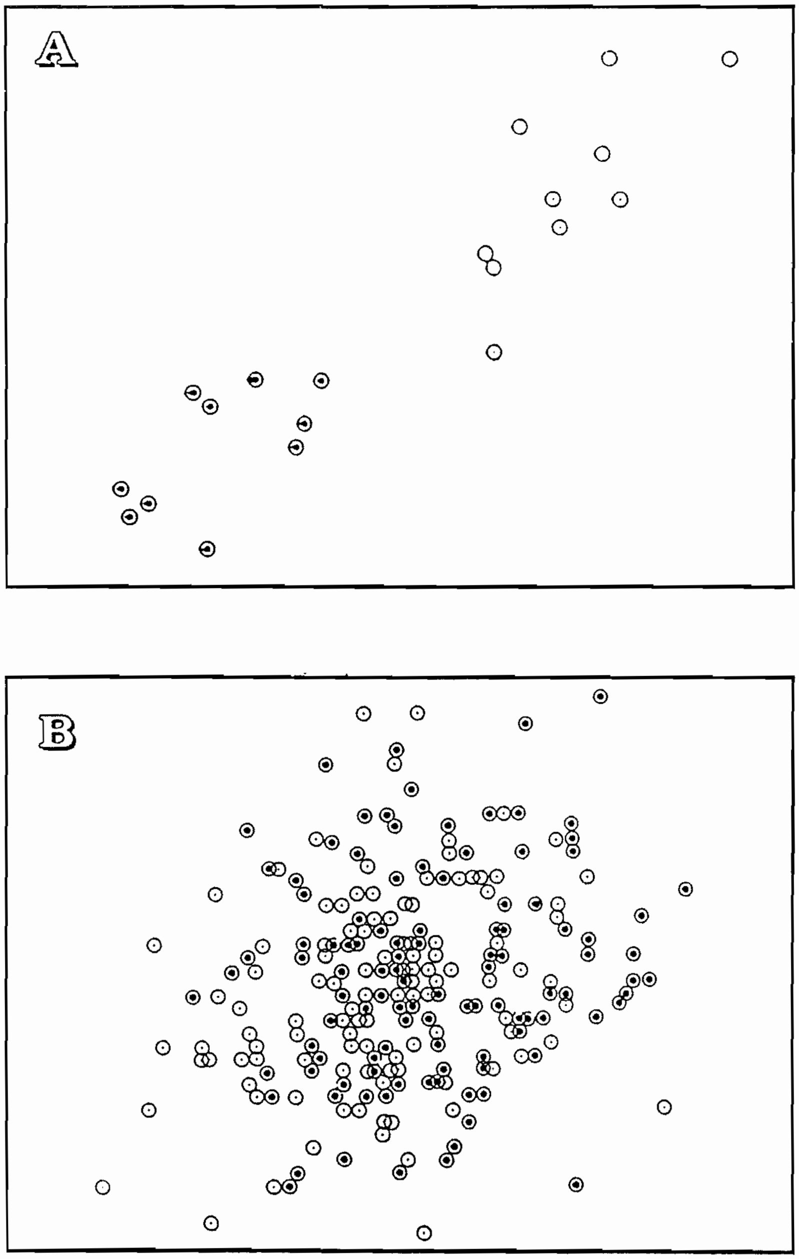


Figure 4.6. Illustration of the curse of High dimensionality. (A) Shows a "perfect" separation between two groups of 10 specimens. (B) Shows that no separation is possible between the two groups when complete and representative populations are used in the analysis.(Note: Scales are different).

Foley (1971), suggests that the ratio of the number of cases (specimens) to the number of parameters (variables such as SiO_2, TiO_2 etc.) should be at least 3 to 1. Most other workers suggest a ratio of 10 to 1 (Le Maitre, 1982; Guillaume 1977; Davis, 1973). If the number of cases is not sufficient, then the number of variables will have to be reduced, using only those variables which are the best discriminators.

4.3.4 Procedure for Discriminant Analysis

The application of discriminant function analysis begins with the selection of the variables to be used in the analysis. Ideally, all numerical parameters should be utilized to capture all of the variability in the data set. However, the number of elements determined in one study may differ from those in another investigation. Thus, a database formed from a collection of geochemical studies will show an uneven number of measured parameters. A general rule of discriminant analysis states that there should be at least ten times more case numbers than there are variables (Le Maitre, 1983). To meet this requirement, certain elements must be omitted from the analysis. Exactly which elements were used in the analysis will be discussed as the results of the analysis on the database are presented in Section 4.5.

The next step consists of determining the number of groups to be used in the analysis. Assigning group membership to each set of observations, must be done using a property (or criterion) which is "independent" of variables used in the computation of the discriminant function in order to avoid pre-judging the results (Le Maitre, 1982). For instance group membership may be assigned on the basis of geographic location, a variable not used in the subsequent calculations of discriminant functions for the geochemical data.

The statistical validity of the derived discriminant function(s) may be tested by spliting the group populations and using the first data set (analysis sample) to calculate the discriminant function, and the second set (the holdout sample) to test the discriminant function. This is done because the classification test will be upwardly biased, that is groups will appear more distinct than in reality, when the same individuals are used for both computing the discriminant analysis and developing the classification matrix. However, once again we are faced with a dilemma of adequate sample size versus valid classification for the discriminant function. Comparison of classification matrices produced both ways, shows very little difference (1-3 %) between these two methods. As discussed in Section 4.3.3, the problem of high dimensionality (which tends to over separate small groups) is much more serious than a misclassification of a few percentage points. Therefore sample splits should only be done when the number of cases is sufficient, and done randomly to avoid introducing bias. Ideally, the procedure should be repeated several times, so that greater confidence can be placed on the validity of the function.

The discriminant function(s) may be computed two ways, with the direct (simultaneous) method or the stepwise method (Nie et al, 1975). The direct method derives the discriminant function(s) using the entire set of variables, regardless of the discriminating power of each. The stepwise method involves entering one variable at a time into the discriminant function(s). The variable with the greatest discriminating power will be selected at each step of the analysis. The discriminating power of the remaining variables is recalculated after each step. Some variables previously selected may be removed if the information they contained is available in a combination of other variables. The process will cease when the remaining variables (if any) no longer contribute significantly to the discriminating power of the function(s) (Nie et al. 1975).

It is difficult to determine which of the two methods is the best to use. Nie et al. (1975) suggest using the direct method to evaluate the discriminating power of the different variables and then employing the stepwise method with only the most discriminating variables. Other statisticians warn users against attempting the stepwise method (Johnson, 1982). As neither method is universally accepted, and particularly given that some doubt exists about the applicability of the stepwise method, only the direct method will be used for computations. Discriminant function analysis was calculated using the statistical package SPSS (Version IX) by Nie et al. (1987).

Once the discriminant functions have been computed, their statistical significance can be evaluated using Chi-square χ^2 (Nie et al, 1975). Unfortunately, this statistic is sometimes misleading. For instance, with large sample sizes, the χ^2 values for various groups may be significantly different even though their group means (or centroids) are almost identical.

Classification matrices may also be used to evaluate the number of specimens correctly classified. As previously discussed, this may be done two ways either by re-running the data through the classification procedure or by using the holdout sample.

Classification of a specimen in discriminant analysis is based on the laws of probability. As such, the percentage of specimens that could be correctly classified by chance warrants some consideration. For example in a two-group analysis where the sample sizes are equal, the chance classification statistic (C) equals 1.0 divided by the number of groups. If the sample sizes were different then C would be based on the sample size of the largest group; this is known as the maximum chance criterion. In such a case, the discriminant function will defy the odds when it classifies a specimen into the smaller group (Morrison, 1969). Because populations used in this study are generally of unequal size, it is important to evaluate the impact of uneven populations on the discriminant models. This will be done in Section 4.3.7.

Comparison of classification results from two separate models could be done using the standard error:

$$S_e = \sqrt{\frac{r/n * (1-r/n)}{n}}$$

where r = total number of correctly classified specimens (all groups)
n = total number of specimens considered in the model

For example, the classification results from two different models can be compared by adding and subtracting their respective $2S_e$ values. If the results do not overlap than the two models can be qualified as significantly different. Again, the reader is reminded that because the same specimens were used in both the calculation of the discriminant function, the classification matrix results will be upwardly biased.

Once the discriminant functions are determined to be statistically significant, and the classification results are acceptable, then the interpretation of the results may begin. Usually the discriminant function will be analyzed to determine the relative importance of each of the variables. The problem of the independence of the compositional data remains an obstacle, as it casts some doubt as to the reliability of the coefficients when considered in isolation.

4.3.5 Discriminant Model

The effects of closure on a data set were discussed in some detail in Section 4.2.6 and it was concluded that the analysis of the data now appeared possible with the use of the log ratio and log centering transformations. However, the problem of the independence of the variables still remains.

To examine the restrictions that such a problem places on the analysis and interpretation of discriminant functions, a theoretical, normally distributed data set of 3 variables was randomly generated using the normal density function:

$$Y = \frac{1}{\sigma\sqrt{2\pi}} \exp[-(x-\mu)^2/2\sigma^2]) \text{ (Le Maitre, 1982)}$$

The distribution of the variables from each group was controlled by preselecting their mean and standard deviation values.

The parameters for each variable and group are presented in Figure 4.7. The distribution of variable A from both groups was made to show some overlap, with different means, but identical variances. Variable B is identical for both groups, and C shows no overlap with different means and standard deviations.

The compositions for the data set were recalculated to 100%. The parameters for each variable and group are presented in Figure 4.7.

Four separate runs of discriminant analysis were done on the basis, composition, log ratio and log centering transformations. The results of the discriminant function coefficients and classification matrices are presented in Figure 4.8.

As a whole, the variation within the data set is essentially maintained thoughout all of the transformations, the measured few percent misclassification are probably related to the inaccuracy of the technique. The problem occurs when we try to interpret the discriminant function coefficients. Usually the magnitude of the absolute values of each coefficient represents the discriminant power of that individual variable, in which the greater the value, the greater the discriminating power. However, if we compare the results of the basis with those results obtained from the log ratio and log centering transformations, it becomes very difficult to put any faith in the coefficients obtained as they differ significantly in magnitude (e.g. variable B, basis=0.01422, logcenter=1.23041, logratio (B/A)= 1.51513).

In a study of distortion induced by closure of data, Skala (1977) found that although distortion of the variates will occur in a closed

Basis Group 1

	A	B	C
Minimum	1.01	0.60	2.03
Maximum	4.99	0.99	5.99
Mean	3.00	0.79	4.00
St. Deviation	0.93	0.09	0.93

	A	B
B	-0.08	
C	0.05	-0.07

Basis Group 2

	A	B	C
Minimum	4.01	0.60	8.00
Maximum	7.99	0.99	9.99
Mean	5.99	0.80	9.00
St. Deviation	0.93	0.09	0.46

	A	B
B	0.05	
C	0.03	0.10

Composition Group 1

	A	B	C
Minimum	13.78	5.51	27.38
Maximum	60.76	18.02	75.85
Mean	38.11	10.54	51.35
St. Deviation	8.69	2.28	8.41

	A	B
B	-0.25	
C	-0.97	-0.01

Composition Group 2

	A	B	C
Minimum	28.64	3.64	48.89
Maximum	47.45	6.80	66.64
Mean	37.80	5.06	57.15
St. Deviation	3.81	0.63	3.59

	A	B
B	-0.42	
C	-0.99	0.27

Figure 4.7. Basic statistics and Pearson correlation coefficents for Model data.

A Basis

Actual Group	No. of Cases	Predicted Group	
		1	2
1	312	312 100.0	0 0
2	312	0 0	312 100.0

Percent correctly classified **100.0**

Discriminant function

Variable	Coefficient
A	0.39714
B	0.01422
C	0.90129

B Composition

Actual Group	No. of Cases	Predicted Group	
		1	2
1	312	287 92.0	25 8.0
2	312	0 0	312 100.0

Percent correctly classified **95.99**

Discriminant function

Variable	Coefficient
A	0.29126
B	1.03776

C Log center

Actual Group	No. of Cases	Predicted Group	
		1	2
1	312	300 96.2	12 3.8
2	312	0 0	312 100.0

Percent correctly classified **98.08**

Discriminant function

Variable	Coefficient
A	0.49925
B	1.23041

D Log Ratio

Actual Group	No. of Cases	Predicted Group	
		1	2
1	312	300 96.2	12 3.8
2	312	0 0	312 100.0

Percent correctly classified **98.08**

Discriminant function

Variable	Coefficient
B	1.51513
C	-1.21977

Figure 4.8. Results from discriminant function analyses done on (a) basis (b) composition (c) log center and (d) log ratio.

system, it is significantly reduced in a system of seven or more variables, to the point where distortion becomes negligible. In order to evaluate this idea another data set of 8 variables (A-H) and 1839 cases was generated in the same manner as discussed above. Parameters and discriminant analysis results are presented in Figures 4.9 and 4.10. In this example, discriminant coefficients for the transformed data better approximate values obtained during the analysis of the basis (e.g variable C basis=.91423 logcenter=.91024 logratio(C/H)= 1.044417). Thus in a rock of essentially 90 chemical components, one would expect that the distortion would be minimal. Even though we do not measure all 90 components in our analysis those that we do measure constitute over 99% of the total volume of the rock, and the remaining space is not sufficient to induce any markable distortion. Therefore the discriminant coefficients will be interpreted in the analysis of the geochemical database.

4.3.6 The Granite Model

Discriminant function analysis is based on the normal distribution theory. Generally the technique is believed to be reasonably robust and will tolerate some departure from normality. The question is, how much will it tolerate?

Generally individual elements in the geochemical database (Appendix D) will show either normal, lognormal (skewed) or bimodal distributions. Therefore, it is of some interest to evaluate how these distributions will affect the discriminant function. In order to investigate these effects, a theoretical granite database was generated using the linear relationships between various major element oxides (Al_2O_3, TiO_2, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O) and SiO_2. Their equations were determined by examining the relationship between the oxides and SiO_2 in the peraluminous granites of Nova Scotia (Figure 4.11).

Basis Group 1

	A	B	C	D	E	F	G	H
Minimum	1.01	0.60	2.03	2.14	2.24	4.61	4.70	5.01
Maximum	4.96	1.00	5.98	6.08	6.18	8.58	8.68	8.98
Mean	3.00	0.80	4.00	4.10	4.20	6.60	6.70	7.00
Variance	0.66	0.01	0.66	0.66	0.66	0.66	0.66	0.66

	A	B	C	D	E	F	G
B	0.016						
C	0.021	-0.080					
D	0.034	-0.017	0.208				
E	0.061	0.002	0.174	0.194			
F	-0.030	-0.007	0.013	-0.037	0.034		
G	-0.043	-0.039	-0.009	-0.048	-0.056	0.313	
H	-0.096	-0.068	-0.046	0.004	-0.041	0.037	0.040

Basis Group 2

	A	B	C	D	E	F	G	H
Minimum	4.01	0.60	8.01	2.14	2.24	4.61	4.70	5.01
Maximum	7.98	1.00	10.00	6.08	6.18	8.58	8.68	8.98
Mean	6.00	0.80	9.00	4.10	4.20	6.60	6.70	7.00
Variance	0.66	0.01	0.16	0.66	0.66	0.66	0.66	0.66

	A	B	C	D	E	F	G
B	0.066						
C	0.005	-0.015					
D	-0.014	0.013	-0.018				
E	-0.026	-0.073	-0.025	-0.038			
F	0.107	-0.020	0.024	-0.008	0.098		
G	0.068	-0.074	0.030	-0.021	0.071	0.263	
H	0.039	-0.062	0.025	0.042	-0.012	0.209	0.208

Figure 4.9. Basic statistics and pearson correlation coefficents for Model data.

Composition Group 1

	A	B	C	D	E	F	G	H
Minimum	2.47	1.40	5.86	6.06	5.89	12.27	12.40	12.27
Maximum	14.32	4.00	17.78	17.21	17.81	25.39	25.98	28.75
Mean	8.23	2.20	10.96	11.24	11.51	18.14	18.42	19.26
Variance	4.55	0.08	4.05	4.02	4.01	4.02	4.33	4.92

	A	B	C	D	E	F	G
B	-0.027						
C	-0.133	-0.153					
D	-0.130	-0.089	0.014				
E	-0.099	0.064	-0.032	-0.004			
F	-0.218	-0.049	-0.263	-0.325	-0.234		
G	-0.211	-0.047	-0.267	-0.309	-0.331	0.159	
H	-0.237	-0.091	-0.256	-0.193	-0.245	-0.105	-0.064

Composition Group 2

	A	B	C	D	E	F	G	H
Minimum	8.48	1.21	15.28	5.39	5.95	10.61	11.35	11.42
Maximum	18.52	2.61	25.14	14.60	15.01	19.20	20.68	21.19
Mean	13.18	1.76	19.82	9.44	10.10	14.93	15.15	15.59
Variance	2.66	0.04	1.52	2.88	2.79	2.19	2.27	2.38

	A	B	C	D	E	F	G
B	0.058						
C	-0.087	0.324					
D	-0.168	-0.012	-0.104				
E	-0.202	-0.098	-0.133	-0.178			
F	-0.170	-0.098	-0.208	-0.253	-0.141		
G	-0.207	-0.142	-0.172	-0.253	-0.165	-0.056	
H	-0.227	-0.099	-0.124	-0.156	-0.257	-0.114	-0.090

Figure 4.9 (cont.). Basic statistics and pearson correlation coefficents for Model data.

Basis

Actual Group	No. of Cases	Predicted Group	
		1	2
1	918	918 100.0	0 0
2	918	0 0	918 100.0

Total percent correctly classified 100.0

Variable	Coefficient
A	.41633
B	.03575
C	.91423
D	-.08859
E	-.03356
F	-.01254
G	.01703
H	.04867

Composition

Actual Group	No. of Cases	Predicted Group	
		1	2
1	918	915 99.7	3 0.3
2	918	0 0	918 100.0

Total percent correctly classified 99.84

Variable	Coefficient
A	.49366
B	-.28712
C	.87173
D	-.07001
E	-.01771
F	-.00746
G	.00209
H	*

Log Center@

Actual Group	No. of Cases	Predicted Group	
		1	2
1	918	903 98.4	15 1.6
2	607	0 0	918 100.0

Total percent correctly classified 99.18

Variable	Coefficient
A	.63932
B	-.12623
C	.91024
D	.02912
E	.07042
F	.01746
G	.01514
H	*

Log Ratio

Actual Group	No. of Cases	Predicted Group	
		1	2
1	918	898 98.5	14 1.5
2	918	0 0	913 100.0

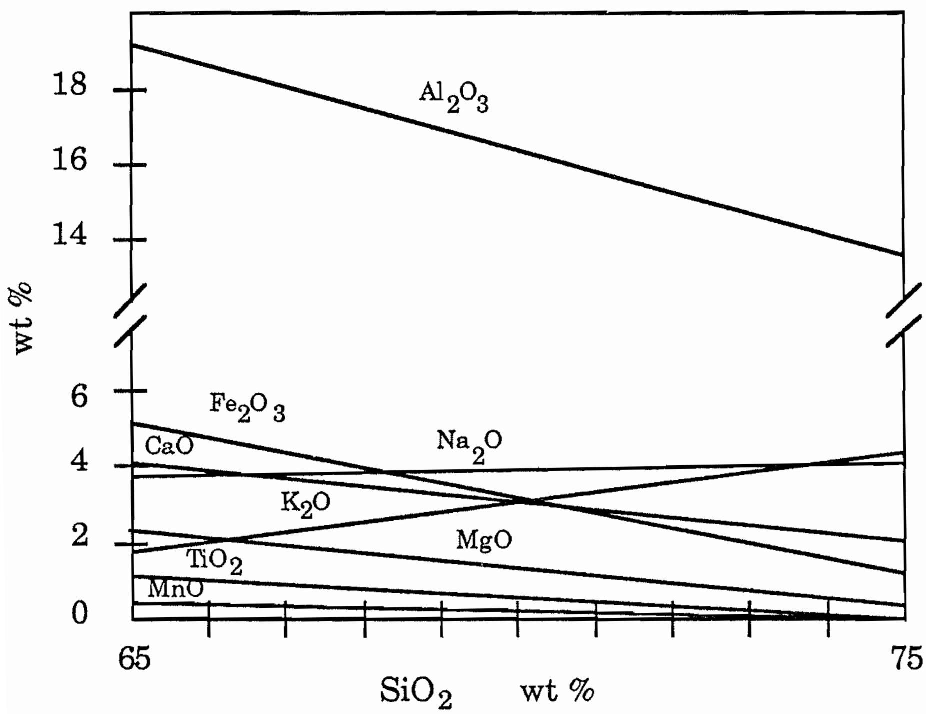
Total percent correctly classified 99.23

Variable	Coefficient
A	.50495
B	-.36970
C	1.04417
D	-.22973
E	-.17134
F	-.16496
G	-.15869

* Variable failed the tolerance test
\# Variables are Log(variable/H)
@ Variables are Log centered

Figure 4.10. Results from Discriminant function analysis of basis, composition, log center and, log ratio of Model 8.

Granite Model



$TiO_2 = (-0.06 \times SiO_2) + 6$

$Al_2O_3 = (-0.375 \times SiO_2) + 41.75$

$Fe_2O_{3t} = (-0.417 \times SiO_2) + 32$

$MnO = (-0.2 \times SiO_2) + 1.1282$

$MgO = (-0.2 \times SiO_2) + 15.2$

$CaO = (-0.222 \times SiO_2) + 18.443$

$Na_2O = (0.0429 \times SiO_2) + 0.8286$

$K_2O = (0.3125 \times SiO_2) - 18.625$

Figure 4.11. Plot and equations of values used in the granite model of Section 4.3.6.

Normally distributed values for SiO_2 were randomly generated using the normal density function. SiO_2 values were then substituted in the equation of Figure 4.11 to determine the values of the other major element oxides. All values were then adjusted to a total of 100%. In this way, a normally distributed comagmatic peraluminous granite database of 304 cases was produced.

The first test consisted of evaluating the effect of bimodal distribution on the discriminant analysis. Three separate bimodal data sets were produced from the original data, by randomly removing mid-case values to produce bimodal distributions of 254, 194 and 124 cases, thus increasing the amount of separation between the groups. The frequency distributions for SiO_2 are presented in Figure 4.12 a-c, and the other oxides, all of which are a function of SiO_2, display similar distributions.

Three separate runs of discriminant analysis were done in which the original data set (304 cases) representing group 1, was compared to each of the three bimodal sets. The data were transformed before discriminant function analysis to eliminate the closure problem by using $X_i = \ln(X_i/SiO_2)$, and SiO_2 was removed from the analysis. In each of these runs, the discriminant analysis could not discriminate between the three pairs of groups (of approximately the same mean and standard deviation).

A second test consisted of evaluating the effect of skewed distributions on the discriminant function. Two data sets were created by randomly removing 50 cases greater than and smaller than 70% SiO_2 from the original data set, thus producing positive and negative skewed distributions. The frequency distributions for SiO_2 are presented in figure 4.12 d-e. The other dependent oxides, not shown, display similar distributions.

Two separate runs of discriminant analysis were done in which the original data set (304 cases) representing Group 1 was compared to each of the skewed sets. The data were transformed as discussed above.

Granite model, bimodal and skewed distributions

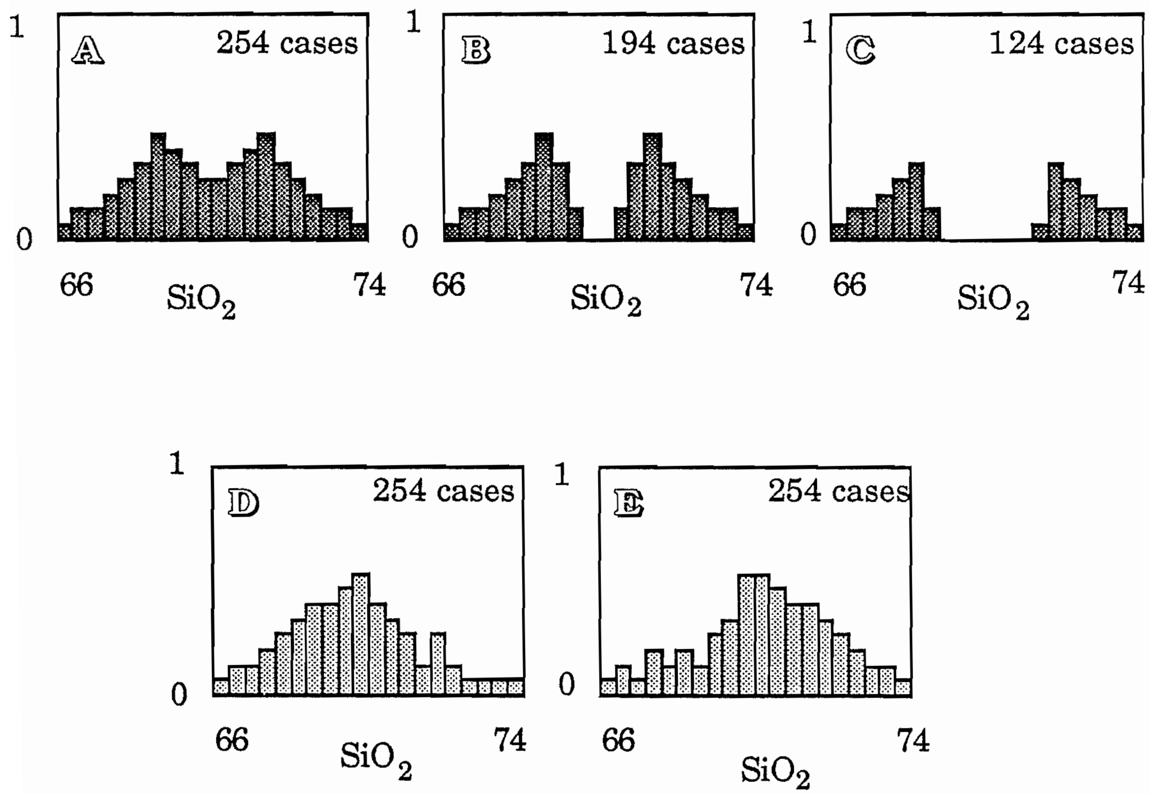


Figure 4.12. Frequency distributions of Bimodal (A, B, and C) and skewed (D and E) populations used in the granite model.

Once again the discriminant analysis could not discriminate between both groups even though the mean and standard deviation of both groups are different.

These results are very encouraging. For example a bimodal distribution as might occur in a zoned granitic pluton, or a skewed distribution as might occur from sampling bias, can be correctly analysed by discriminant function analysis. Further tests showed that when the degree of skewness is increased to the point where it becomes similar to the lognormal form (i.e. mean values are significantly changed), results of the discriminant analysis are affected.

4.3.7 The Effect of Group Sample Size on the Maximum Chance Criterion

Differences in group size during discriminant analysis was identified as a potential problem in Section 4.3.4. The geochemical populations compared in this thesis are generally of unequal size. In order to validate these analysis a test model was run to determine the impact of uneven population sizes on the discriminant analysis.

A normaly distributed population of 2430 granite analysis was generated in the same manner as discussed in Section 4.3.6. From this 2430 case population (hereby known as Group 1) six separate groups of 1215, 607, 405, 304, 243 and 162 cases were randomly taken. Each of these 6 populations (Group 2) were then compared with the original population (Group 1) using discriminant analysis. Ideally no separation between the groups should occur given that each of the separated populations were taken from Group 1 and therefore all groups should be identical. The results of the 6 runs are presented in Figure 4.13. The reader will note that significant deviations from expected results occur, in figure 4.13, when the difference in size between the two groups is equal to or greater than 10:1.

In reality two factors are being considered in this mode: The first is the effect of group size on the maximum chance criterion and a second unescapable factor which is the representativity of the population within the sample group. In other words, are the randomly separated groups truly representative of the original population?

It can be argued that Model 6 (Figure 4.13) suggests that believable results can be obtained when the group size difference is 1:15. The deviations from expected values in Models 4 and 5 can be related to the probability of obtaining a representative sample group from the original population. When a sample group was taken from the original population a random number generator was used to determine whether or not a case (granite analysis) should be included in the sample group. If a number less than 0.5 was obtained by the random numbers generated the case was not included in the sample group if a value greater than 0.5 was obtained it was included. This process was repeated for each case until the target total number of cases was obtained. It is at this stage that some bias could have been introduced in the sample group causing the observed deviations in the results in the Models of Figure 4.17.

In sum it can be concluded that if the difference in group size is less than 10:1, no significant effect on the discriminant results should occur.

4.4 Summary

In this chapter it was demonstrated that multivariate analysis of compositional data could be done using the log ratio transformation to eliminate the constant-sum problem. The applicability of discriminant analysis to the geochemical data (granite analyses) was also demonstrated using various test models. Bimodal and skewed populations and, uneven sample groups (up to 10:1) can all be successfully analysed using discriminant function analysis. It was also concluded that the discriminant function coefficients were reliable, and that the classification matrix represented the best method of determining the efficiency of the separation during the analysis.

Maximum Chance Criterion

No. of cases in Group 1	No. of cases in Group 2	Group 2 as % of Group 1	Classification Matrix: Actual Group	No. of Cases	Predicted Group 1	Predicted Group 2	Total percent correctly classified
2430	1215	50 % (1/2)	1	2430	1336 55.0	1094 45.0	51.85
			2	1215	661 54.4	554 45.6	
2430	607	25 % (1/4)	1	2430	1081 44.5	1349 55.5	47.02
			2	607	260 42.8	347 57.2	
2430	405	17 % (1/6)	1	2430	912 37.5	1518 62.5	42.12
			2	405	123 30.4	282 69.6	
2430	304	12 % (1/8)	1	2430	902 37.1	1528 62.9	40.45
			2	304	100 32.9	204 67.1	
2430	243	10 % (1/10)	1	2430	869 35.8	1561 64.2	39.13
			2	243	66 27.2	177 72.8	
2430	162	7 % (1/15)	1	2430	1129 46.5	1301 53.5	47.15
			2	162	69 42.6	93 57.4	

Figure 4.13. Discriminant analysis model results testing the effect of group size on the maximum chance criterion.

CHAPTER 5

STATISTICAL MODELLING OF THE GEOCHEMICAL DATABASE

5.1 Introduction

Discriminant analyses of peraluminous granites from Nova Scotia, Morocco and Iberia are presented in this chapter. Data from Australia are also included in some of the statistical tests for comparative purposes. These analysis were undertaken in an attempt to answer the following questions:

1) Can a discriminant function be determined to distinguish clearly between the northern and southern plutons of Nova Scotia?

2) To what extent are the Nova Scotian and Moroccan granites similar?

3) Do the Nova Scotian granites show more geochemical affinity with the Moroccan or the Iberian granites?

4) Are variations measured locally (within Nova Scotia), regionally (between Nova Scotia and Morocco), within an orogenic belt (Nova Scotia, Morocco, Iberia) and between orogenic belts (when compared with Australia) characteristic of the scale of measurement?

Results on the processing of the geochemical data are presented in this chapter. Discussion on the results follow in Chapter 6.

5.2 Data Preparation

Before attempting multivariate analysis on the geochemical data certain steps need to be taken to ensure that such analysis can be applied to the data. These include both geological and mathematical considerations, all of which are summarized below. It can not be overemphasized how important these considerations are to a proper, correct and believable analysis of the data.

A) Carefully define the scope of the problem to be resolved. We are all familiar with the phrase "garbage in, garbage out", and if data not applicable to the problem are included in the analyses, incorrect or misleading results may be obtained. In this case the intent of the analysis is to evaluate the degree of variation/similarity between granitic rock from different geographic areas, and it was decided that granitic rocks which showed clear evidence of secondary processes should not be included in the database, as such processes can not always be related to the granite in question. Their inclusion would add an undesirable uncertainty to the reliability of the results.

Another geological consideration is that only peraluminous granites are found within the Meguma Zone, therefore only peraluminous granites should be included in comparisons. They should also intrude Paleozoic rocks, as this is characteristic of the Meguma granites. In addition to the data from Nova Scotia and Morocco some data from Iberia were also used in certain analyses. Details on provenance are given in Appendix E. It should be pointed out that the Iberian granites are peraluminous, intrusive within Paleozoic terranes, and Hercynian in age. Details on Australian data are also given in Appendix E.

B) The distribution for each parameter used in statistical analysis must be examined to ensure that all the data are normally distributed. If the data are not normally distributed, then transformation may be necessary.

Transformation of the major element data are done to eliminate the constant sum problem. Two transformations may be applied: the log ratio or the log centering tranformation. As discussed in Chapter 4 log centering effectively recreates closure, thus the log ratio transformation is preferred. All the major element data used in the discriminant analysis have been transformed using $Z_i = \ln(X_i/X_j)$ with $i = 1,2...D$ where i does not equal j.

Trace element data are generally not lognormally distributed in the strictest sense of the word (Appendix E). However most minor-element distributions are far more similar to the lognormal than the normal. Although the statistical methods used in this study are supposedly robust with respect to the form of the distribution departures of most trace elements from normality are so large that the use of normal probability theory on untransformed data could be risky. It is preferable to effect log transformation before processing the data. Therefore trace element data were transformed using $Z = \ln(x)$.

Although certain major element populations display bimodal distributions (Appendix B), they are still considered to represent only one population.

C) Critical review of results obtained during the analysis is essential. Statistical results must be supported by geological evidence to be acceptable and, should confirm what is already suspected and if unexpected results are obtained they should be scrutinized thoroughly.

5.3 Basic Assumptions

As with any attempt to model data, these statistical models depend on underlying assumptions. These assumptions are given below.

1- The Meguma granites were emplaced before the docking of the terrane onto eastern North America, and therefore should correlate with some other area (geological evidence; deformation of the granites along the suture)

2- The granites do not show any significant facies differences across the wide Scotian shelf.

3- Restrictions placed on which granites should be included in the database are correct (i.e. composition, age and association).

4- Analytical errors and interlaboratory differences are of no serious consequence (i.e. they do not make the data appear either more similar or more different).

5- Applied transformations to the geochemical data (log ratio for the majors and log for the traces) are correct.

6- Granite compositions have more to do with the source and the sum of processes which affect the granite throughout its evolution than with time itself.

5.4 Database Limitations

The geochemical database used in this study consists of both major and trace element analysis, mostly collected from bibliographic sources. Intuitively, trace elements are expected to be better discriminators than major elements. This is due to the fact that the granitic classification restricts major element variation, but not trace elements.

The frequency of measurements for each parameter in the database are shown in Figure 5.1. Ideally, all available variates should be used in a discriminant analysis, however, for many trace elements, the number of cases is simply not sufficient to ensure that the ratio of the number of measurements to variates is at least 10:1. This, of course, means that possibly some of the better discrimators (trace elements) can not be included because of database restrictions.

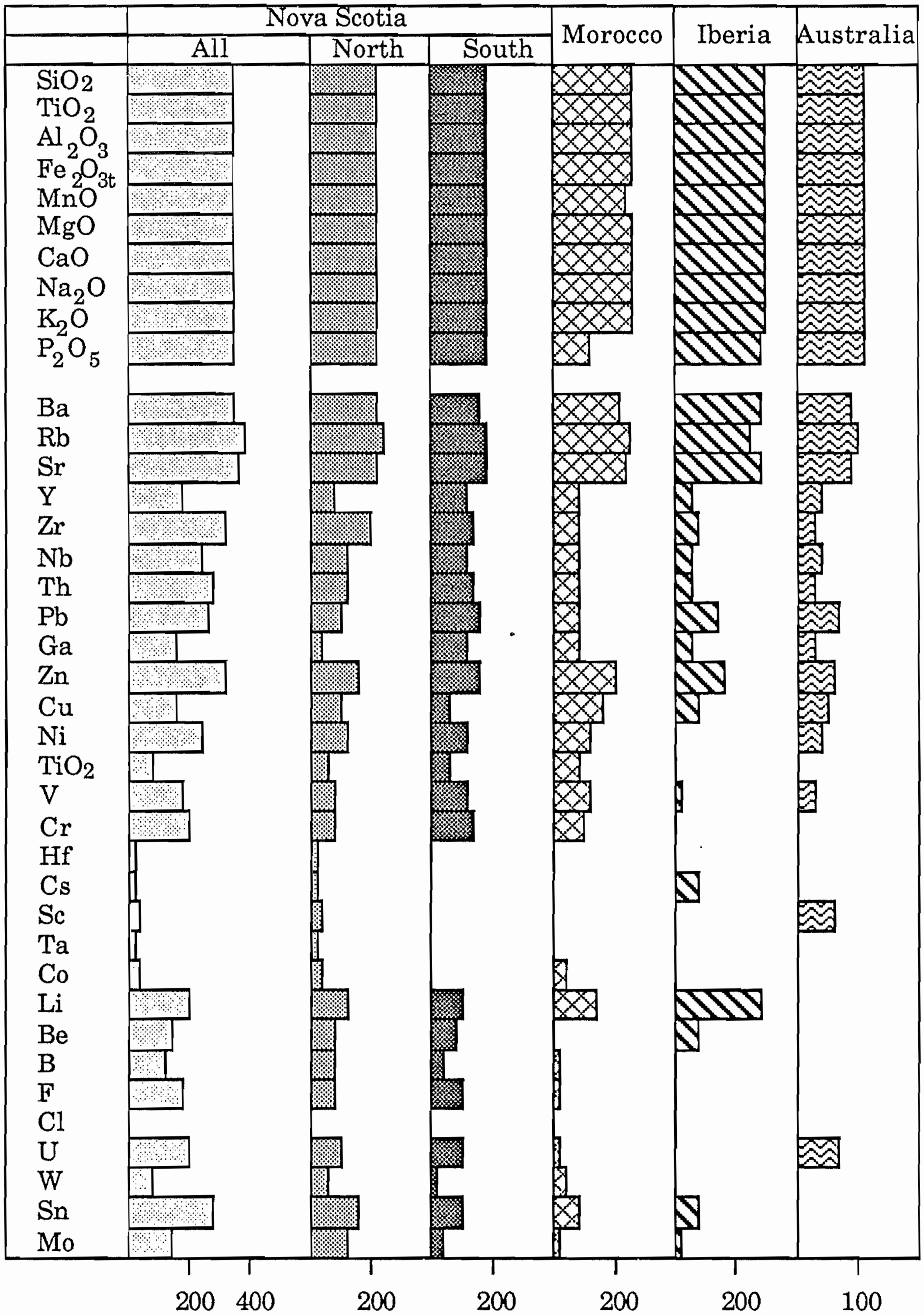


Figure 5.1. Frequency distribution of measured parameters for each granite population used in the geochemical models.

5.5 Northern and Southern Plutons of Nova Scotia

5.5.1 Introduction

Three separate runs of discriminant analysis on the northern and southern plutons of Nova Scotia are presented in this Section. These were selected as the most informative from a considerable number analyses done during this study. The purpose behind these analyses was to determine whether the northern and southern plutons could be successfully distinguished. The reader will recall that previous analysis presented in Chapter 3 suggested that some differences existed between both areas, however, no binary or ternary diagram could be succesfully developed to distinguish clearly geochemically between both areas.

5.5.2 Model 1 (North-South, Nova Scotia)

5.5.2.1 Results of Model 1 (North-South, N.S.)

A first model was run using SiO_2 - TiO_2 - Al_2O_3 - Fe_2O_{3t} - MgO - CaO - Na_2O - K_2O - P_2O_5 - Ba - Rb - Sr. Variables were selected by examining the frequency of measurements for each parameter in Figure 5.1. Making certain that the ratio of variates to number of measurements was at least 10:1. The reader is reminded that all major oxides have been normalized to SiO_2 (oxide/SiO_2).

Figure 5.2 illustrates the frequency distribution of the discriminant scores for the two groups. The discriminant function and classification matrix are presented in Figure 5.3. A detailed listing of the classification matrix for each pluton is also presented in Figure 5.3.

Rb, Ba, CaO, Sr, and TiO_2 with absolute discriminant coefficients greater than 0.4 are considered important discriminators. K_2O, Fe_2O_{3t} and P_2O_5 with coefficient values between 0.4 and 0.3 are in this

Model 1 - Nova Scotia (North-South)

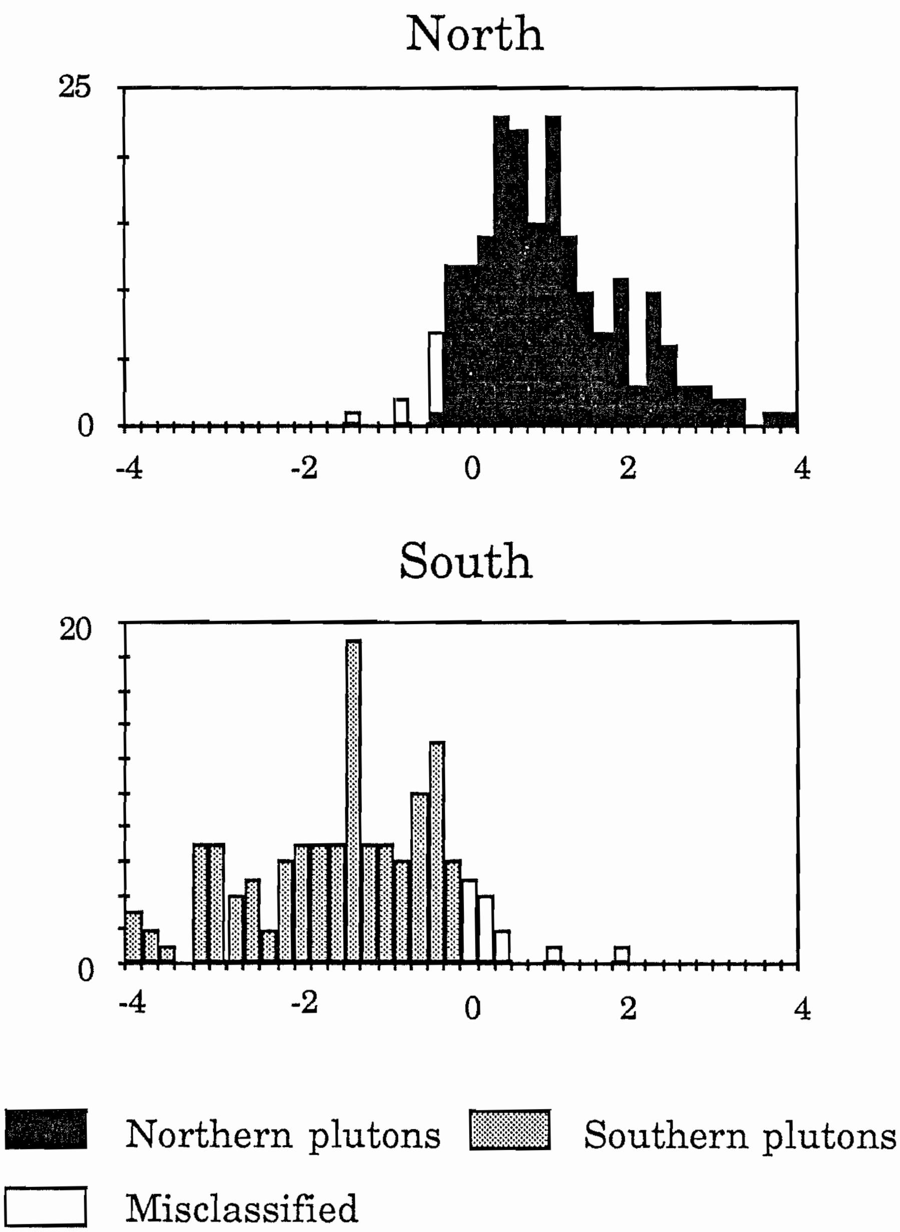


Figure 5.2. Frequency plot of discriminant scores from Model 1.

Model 1 - Nova Scotia (North-South)

Detailed Classification Matrix

		GRANITE		CORRECTLY CLASSIFIED		MISCLASSIFIED	
NOVA SCOTIA	North	SMB	Charest	17	100.0%	0	0.0%
		SMB	McKenzie	16	88.9%	2	11.1%
		SMB	Smith	32	100.0%	0	0.0%
		SMB	Richardson	8	100.0%	0	0.0%
		Musquodoboit		9	90.0%	1	10.0%
		Liscomb		8	88.9%	1	11.1%
		Sherbrooke		17	94.4%	1	5.6%
		Bull Ridge		10	83.3%	2	16.7%
		Sangster Lake & Larry's River		29	96.7%	1	3.3%
		Queensport & Halfway Cove		36	100.0%	0	0.0%
		Ellison Lake		13	92.9%	1	7.1%
	South	Barrington Passage		31	100.0%	0	0.0%
		Shelburne		22	81.5%	5	18.5%
		Bald Mountain		4	100.0%	0	0.0%
		Port Mouton		50	96.1%	2	3.9%
		Moose Point		6	75.0%	2	25.0%
		Lyons Bay, Seal Island, Western Granite		6	60.0%	4	40.0%

Discriminant Function

Rb	0.94774
Ba	-0.69987
CaO	-0.62054
Sr	0.50335
TiO_2	0.50259
K_2O	0.39666
Fe_2O_{3t}	0.31488
P_2O_5	-0.30121
MgO	0.11960
Na_2O	0.03353

Classification Matrix

			Predicted Group	
			North	South
Actual Group	North	204	195 95.6%	9 4.4%
	South	133	13 9.8%	120 90.2%

Total Correct 93.47%

Figure 5.3. Discriminant function, detailed and summary classification matrix for Model 1.

function of lesser importance. The reader will note that Al_2O_3 is not found in the discriminant function, i.e. Al_2O_3 failed the minimum tolerance test and was excluded from the analysis (for more information on the minimum tolerance test see Appendix F).

The classification matrix of Figure 5.3 indicates that 93.47 % of all cases were correctly classified during the analyses. This suggests that the northern and southern plutons of Nova Scotia are in effect geochemically different.

5.5.2.2 Discussion of Model 1 (North-South, N.S.)

Analysis of the northern and southern granites of Nova Scotia was undertaken in an attempt to characterise variation within this area. A dividing line (Figure 2.1) was drawn based on geological evidence which indicated some difference in the evolution of these granites (see Chapter 2 for detailed discussion). Group membership for the Nova Scotian Models (including subsequent Models 2 and 3) were determined based on this division. As a result of these model contraints the following conclusions can be drawn from this analyses. The northern and southern plutons are in effect statistically distinct, and membership to each group can be defined by the discriminant function. Based on this equation (discriminant function) a new chemical analysis from the Nova Scotian granites could be correctly classified 93.47% of the time, i.e. its provenance from either the northern or southern plutons could be correctly predicted in 93.47% cases. The standard error (S_e) for Model 1 is 1.35 %.

The discriminant scores of individual data vectors were examined to investigate which analyses were not correctly classified, particularly to decipher any existing misclassification patterns (Figure 5.3). Generally, the more "mafic" members of the northern plutons (eg. granodiorites from the South Mountain Batholith and Liscomb Pluton) as well as the more "felsic" members of the southern plutons (monzogranites from Moose point, Shelburne, Lyons Bay etc...)

are misclassified by the analyses. This observation is difficult to interpret. It may simply reflect that given the restricted number and the nature of variates used in the analyses, differences relating to the degree of mafic or felsic component are being emphasised. Another possible explanation is that the extreme compositions within both groups are simply not that different. Alternatively perhaps no meaning should be read into these misclassified cases, given the very low percentage of misclassified samples.

5.5.3 Model 2 (North-South, Nova Scotia)

5.5.3.1 Results of Model 2 (North-South, N.S.)

Potentially, with the addition of more trace elements, discrimination between the two groups should improve, therefore, to better constrain the modelling, some trace elements were added in the following analyses. However, because of the limitations imposed by the number of measurements, some parameters previously used in Model 1 had to be omitted from further analysis. Variates retained in the analyses were selected on the basis of their discriminating power in the function of Model 1.

A second run (Model 2) was done using SiO_2 - TiO_2 - CaO - K_2O - Ba - Rb - Zr - Zn - Th (again major oxides were normalized to SiO_2). Figure 5.4 illustrates the frequency distribution of the discriminant scores for each group. The discriminant function and classification matrix are presented in Figure 5.5. A detailed listing of the classification matrix for each pluton is also shown in Figure 5.5.

Rb, TiO_2, Ba, Sr, are important discriminators in this function, and Th, Zr, CaO, K_2O and Zn appear to be of lesser significance. The classification matrix of Figure 5.5 indicates that 91.51 % of all cases were correctly classified during the analysis with a S_e = 1.91%. Once again the northern and southern plutons appear to be geochemically different.

Model 2 - Nova Scotia (North-South)

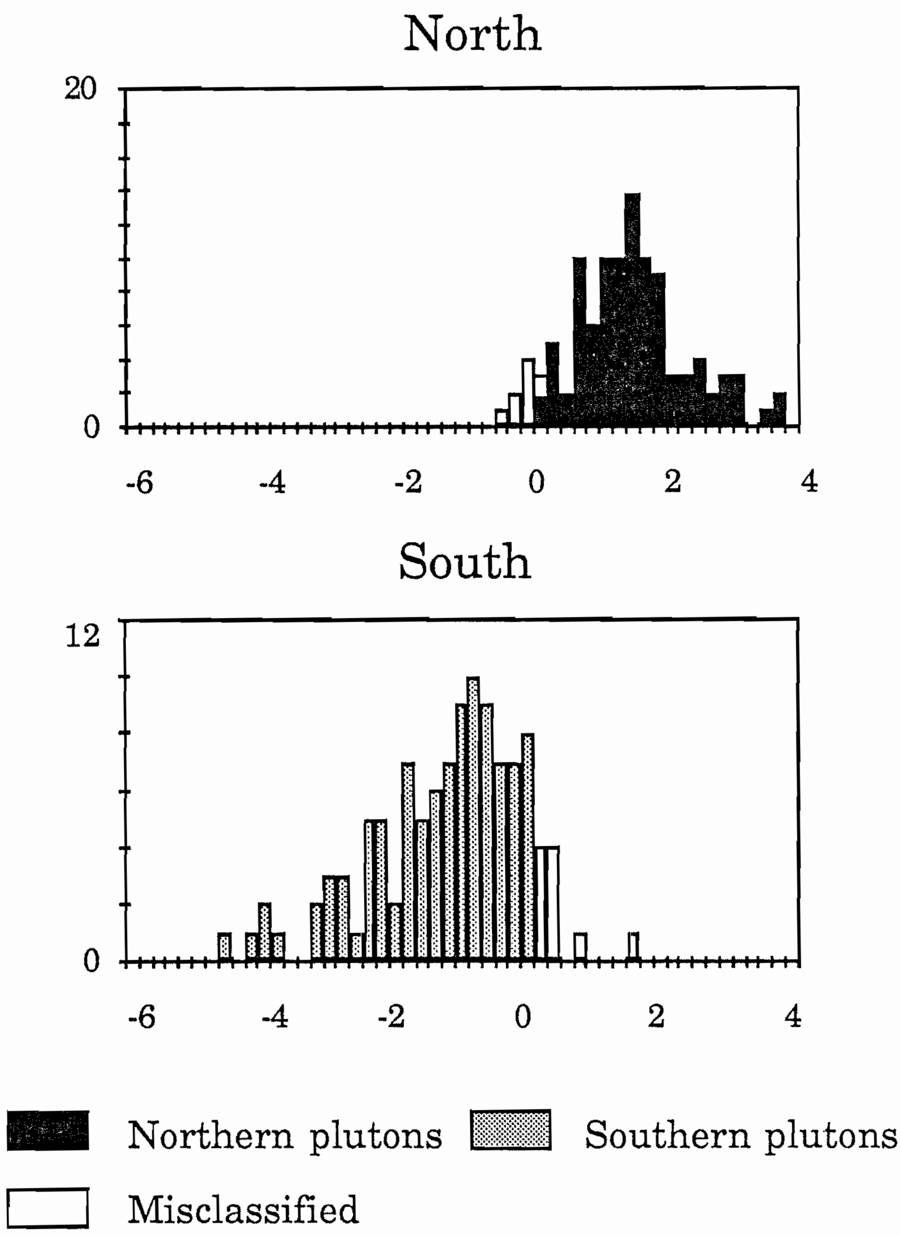


Figure 5.4. Frequency plot of discriminant scores from Model 2.

Model 2 - Nova Scotia (North-South)

Detailed Classification Matrix

		GRANITE		CORRECTLY CLASSIFIED		MISCLASSIFIED	
NOVA SCOTIA	North	SMB	Charest	-	- %	-	- %
		SMB	McKenzie	3	37.5%	5	62.5%
		SMB	Smith	-	- %	-	- %
		SMB	Richardson	6	100.0%	0	0.0%
		Musquodoboit		9	100.0%	0	0.0%
		Liscomb		5	62.5%	3	37.5%
		Sherbrooke		13	100.0%	0	0.0%
		Bull Ridge		-	- %	-	- %
		Sangster Lake & Larry's River		27	100.0%	0	0.0%
		Queensport & Halfway Cove		36	100.0%	0	0.0%
		Ellison Lake		-	- %	-	- %
	South	Barrington Passage		26	0.0%	0	0.0%
		Shelburne		22	95.7%	1	4.3%
		Bald Mountain		0	0.0%	3	100.0%
		Port Mouton		38	88.4%	5	11.6%
		Moose Point		-	- %	-	- %
		Lyons Bay, Seal Island, Western Granite		9	90.0%	1	10.0%

Discriminant Function

Rb	0.90684
TiO_2	0.79808
Ba	-0.61060
Sr	0.57276
Th	0.32050
Zr	-0.31923
CaO	-0.28093
K_2O	0.26254
Zn	-0.22088

Classification Matrix

			Predicted Group	
			North	South
Actual Group	North	107	99 92.5%	8 7.5%
	South	105	10 9.5%	95 90.5%

Total Correct 91.51%

Figure 5.5. Discriminant function, detailed and summary classification matrix for Model 2.

5.5.3.2 Discussion of Model 2 (North-South, N.S.)

Obviously the addition of new trace elements in this model have not improved the degree of separation between the two groups (from 93.47 % $\pm$ 2.70 (at $2S_e$) in Model 1 to 91.51 % $\pm$ 3.82 (at $2S_e$) in this model). These results overlap considerably and cannot be considered statisticaly different. It is difficult to predict whether the inclusion of the major elements used in Model 1 would contribute measurably to the discrimination, and this question can not be answered until the number of variates and cases are increased in the database.

Examination of misclassified samples in Figure 5.5 reveal that extreme compositions (i.e. granodiorites of SMB from McKenzie and the Liscomb pluton, and monzogranites from the Port Mouton pluton) are still being misclassified. All three samples from the Bald Mountain pluton are also being misclassified during the analyses, all of these are monzogranites. Again it is difficult to assess the significance of the misclassifications, as so few cases are being misclassified.

The reader will note the limited amount of data used from the South Mountain Batholith, and especially the decrease in the overall number of cases as well as number of plutons used in the analyses. This may result in a decrease in the variation between populations and account for the sligthly lower discrimination.

5.5.4 Model 3 (North-South, Nova Scotia)

5.5.4.1 Results of Model 3 (North-South, N.S.)

In a third run of the Nova Scotian granites Pb was included in the list of variables, in addition some of the better discriminators of Models 1 and 2 were also selected for the analyses, therefore Model 3 includes the following variables: SiO_2 - TiO_2 - CaO - K_2O - Ba - Rb - Sr - Zr - Zn - Th - Pb.

Model 3 - Nova Scotia (North-South)

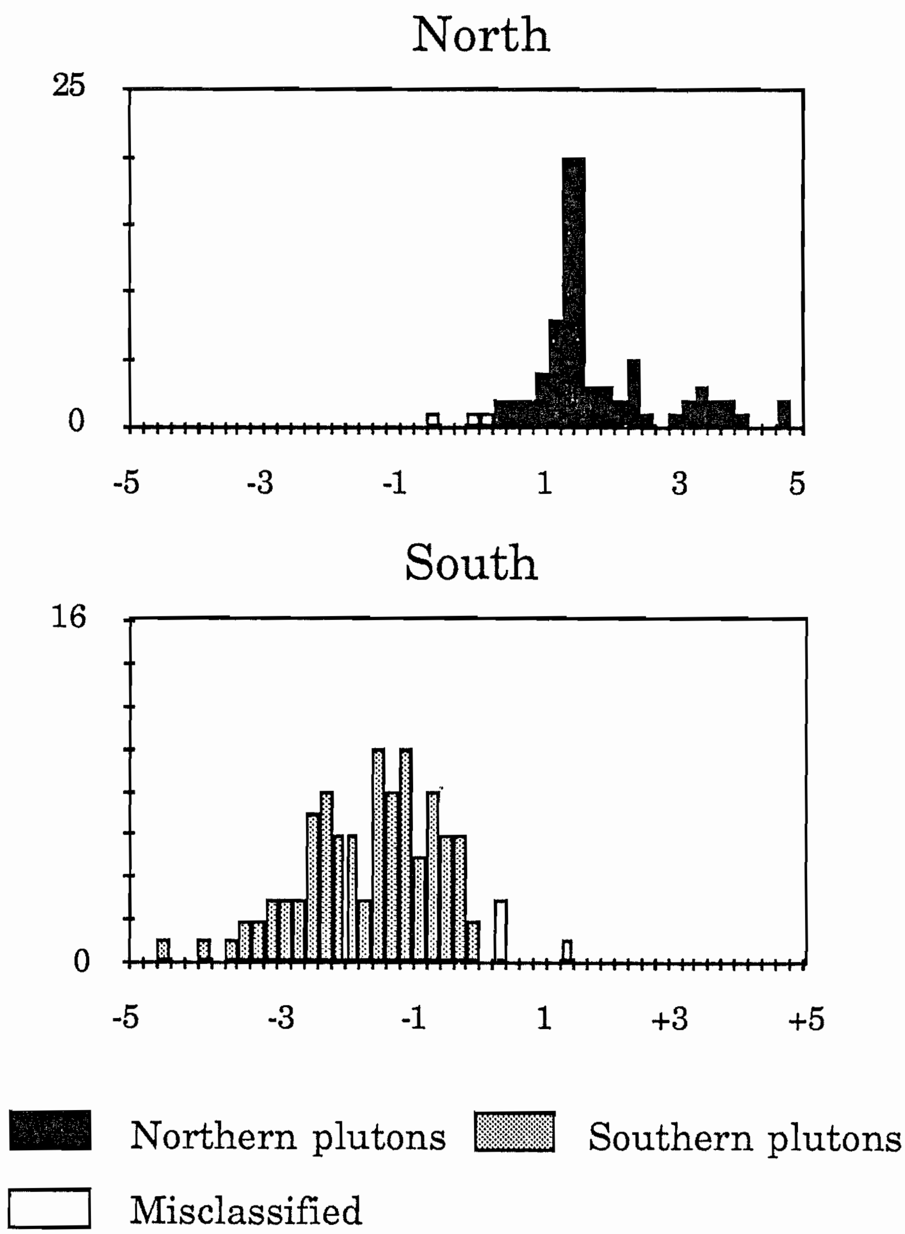


Figure 5.6. Frequency plot of discriminant scores from Model 3.

Model 3 - Nova Scotia (North-South)

Detailed Classification Matrix

		GRANITE		CORRECTLY CLASSIFIED		MISCLASSIFIED	
NOVA SCOTIA	North	SMB	Charest	-	- %	-	- %
		SMB	McKenzie	-	- %	-	- %
		SMB	Smith	-	- %	-	- %
		SMB	Richardson	5	83.3%	1	16.7%
		Musquodoboit		-	- %	-	- %
		Liscomb		5	71.4%	2	28.6%
		Sherbrooke		13	100.0%	0	0.0%
		Bull Ridge		-	- %	-	- %
		Sangster Lake & Larry's River		27	100.0%	0	0.0%
		Queensport & Halfway Cove		36	100.0%	0	0.0%
		Ellison Lake		-	- %	-	- %
	South	Barrington Passage		26	100.0%	0	0.0%
		Shelburne		22	95.7%	1	4.3%
		Bald Mountain		2	66.7%	1	33.3%
		Port Mouton		42	97.7%	1	2.3%
		Moose Point		-	- %	-	- %
		Lyons Bay / Seal Island / Western Granite		9	90.0%	1	10.0%

Discriminant Function

Sr	1.32740
Rb	1.24913
Ba	-1.02254
Pb	0.63290
TiO_2	0.59358
CaO	-0.41234
Th	0.27591
Zr	-0.20109
Zn	-0.16912
K_2O	-0.07839

Classification Matrix

			Predicted Group	
			North	South
Actual Group	North	90	87 96.7%	3 3.3%
	South	105	4 3.8%	101 96.2%

Total Correct 96.41%

Figure 5.7. Discriminant function, detailed and summary classification matrix for Model 3.

The frequency distribution of the discriminant scores for each group is shown in Figure 5.6. The discriminant function and classification matrix are presented in Figure 5.7. A detailed listing of the classification matrix for each pluton is also presented in Figure 5.7.

Sr, Rb, Ba, Pb, TiO_2, CaO with coefficient values greater than 0.4 are considered important discriminators. Th, Zr, Zn and K_2O contribute to a lesser degree. The classification matrix of Figure 5.7 indicates that 96.41 % (with a S_e of 1.33 %) of all cases were correctly classified during the analysis, and once again confirms the geochemical distinction between the northern and southern plutons.

5.5.4.2 Discussion of Model 3 (North-South, N.S.)

Model 3 with a number of correctly classified cases at 96.41 % $\pm$ 2.66 (at $2S_e$), represents the best separation obtained for the Nova Scotian granites in this study and with such a high value the Meguma granites can be characterized as geochemically distinct. Upon further scrutiny of the results some weaknesses become apparent in the Model. For instance, the analyses includes very little data from the SMB and none from the Musquodoboit batholith, as they account for a high proportion of the granite outcrop within Nova Scotia perhaps, their exclusion may have lead to slight modification in the results. This would occur if the absence of data from these two important granitic bodies induced some changes in the characteristics of the northern populations, and these distortions may account for the few percent differences with previous models.

Generally similar observations presented for previous Nova Scotian Models appear to apply here. Some granodioritic samples from the Liscomb pluton are still being misclassified.

5.5.5 Discussion of the Nova Scotian Models

The following observations can be made about the three models presented in this section:

1) The northern and southern plutons of Nova scotia can be successfully distinguished geochemicaly, even with the limited number of variates used in the models.

2) The few percent misclassified samples seem to be of extreme composition. That is, the more mafic members of the northern plutons and the more felsic members of the southern plutons are being misclassified. This may be the result of the nature and number of variates used in the models. This may also indicate that the intermediate compositions are similar for both groups. Alternatively because of their small numbers, their misclassification may simply mean nothing.

3) The importance of an element in the discriminant function (i.e. the value of the coefficient) may vary slightly between models. Even though many different functions can be defined to effectively separate the two groups, some elements are consistently excellent discriminators in all of the models considered in this study. This is illustrated in Figure 5.8 where generally Rb, Sr, Ba, TiO_2, CaO and Pb are considered the most significant discriminators in Nova Scotia.

5.6 Nova Scotia and Morocco

5.6.1 Introduction

Three separate runs of discriminant analysis on the granites of Nova Scotia (north and south are combined) and Morocco are presented in this Section. As in the previous section these were selected as the most informative from a number of analysis carried out during the course of this study. These analysis were done in order to examine the

Nova Scotia (North-South) Models

Absolute Coefficient Value	**Model 1**	**Model 2**	**Model 3**	
$C > 0.8$	Rb	Rb	Sr Rb Ba	**Significant Discriminator**
$0.8 > C > 0.6$	Ba CaO	TiO_2 Ba	Pb	
$0.6 > C > 0.4$	Sr TiO_2	Sr	TiO_2 CaO	
$0.4 > C > 0.2$	K_2O Fe_2O_{3t} P_2O_5	Th, K_2O Zr, Zn CaO	Th Zr	**Discriminator of Less Significance**
$0.2 > C > 0.0$	MgO Na_2O		Zn K_2O	

Figure 5.8. Generally Rb, Sr, Ba, TiO_2, CaO, and Pb are the most significant discriminators within Nova Scotia.

geochemical relationship between the Nova Scotian and Moroccan granites.

5.6.2 Model 4 (Nova Scotia - Morocco)

5.6.2.1 Results of Model 4 (Nova Scotia-Morocco)

Model 4 was run using SiO_2 - TiO_2 - Al_2O_3 - Fe_2O_{3t} - MgO - CaO - Na_2O - K_2O - Ba - Rb - Sr. Figure 5.9 illustrates the frequency distribution of the discriminant scores for each group. The discriminant function and classification matrix are presented in Figure 5.10. A detailed listing of the classification matrix for each pluton is also presented in Figure 5.10.

Sr, MgO, Rb, CaO, Na_2O, Al_2O_3 and Ba with coefficient values greater than 0.4 are important discriminators; K_2O, TiO_2 and Fe_2O_3 contribute to a lesser degree. With a classification value of 80.84 % (S_e = 1.72 %), Nova Scotia and Morocco can not be characterized as geochemically distinct, such a value indicates some similarity between both areas.

5.6.2.2 Discussion of Model 4 (Nova Scotia - Morocco)

Variates which were considered important discriminators within Nova Scotia (i.e. locally), particularly TiO_2 and, to a lesser extent Ba, are no longer important regionally (between Nova Scotia and Morocco). Conversely, good regional discriminators such as MgO, Na_2O and Al_2O_3 are of little consequence locally.

The classification matrix shows that 80.84 % of all cases were correctly classified during the analyses, indicating a certain amount of similarity between both areas. The detailed listing of the classification matrix in Figure 5.10 reveals a great deal of similarity between the Central and Rehamna Massifs of Morocco, and Nova Scotia (a considerable number of cases from both massifs are misclassified).

Model 4 - Nova Scotia - Morocco

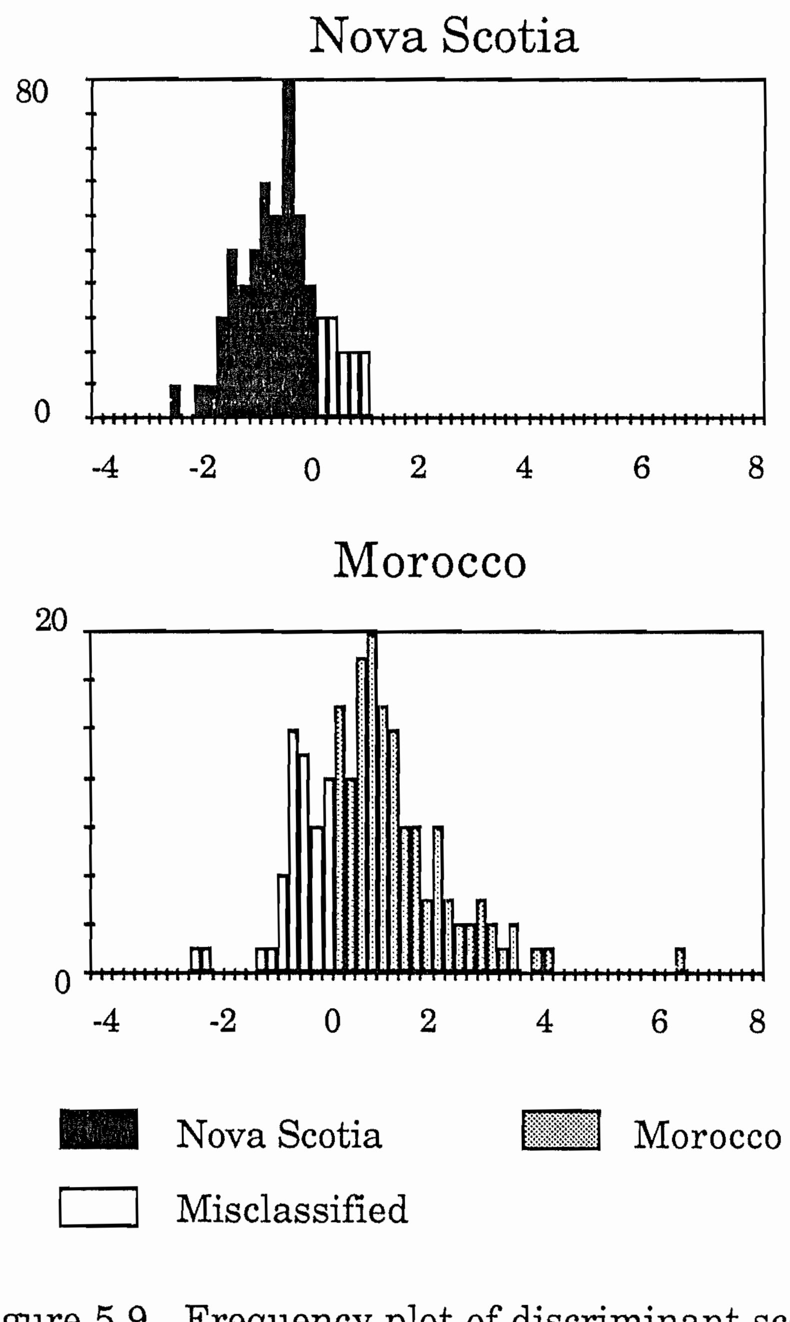


Figure 5.9. Frequency plot of discriminant scores from Model 4.

Model 4 - Nova Scotia - Morocco

Detailed Classification Matrix

		GRANITE		CORRECTLY CLASSIFIED		MISCLASSIFIED	
NOVA SCOTIA	North	SMB	Charest	16	94.1%	1	5.9%
		SMB	McKenzie	18	100.0%	0	0.0%
		SMB	Smith	26	81.2%	6	18.8%
		SMB	Richardson	8	100.0%	0	0.0%
		Musquodoboit		9	90.0%	1	10.0%
		Liscomb		9	100.0%	0	0.0%
		Sherbrooke		10	55.6%	8	44.4%
		Bull Ridge		12	100.0%	0	0.0%
		Sangster Lake & Larry's River		26	86.7%	4	13.3%
		Queensport & Halfway Cove		30	83.4%	6	16.7%
		Ellison Lake		0	0.0%	14	100.0%
	South	Barrington Passage		27	87.1%	4	12.9%
		Shelburne		25	96.2%	1	3.8%
		Bald Mountain		4	100.0%	0	0.0%
		Port Mouton		47	90.4%	5	9.6%
		Moose Point		5	62.5%	3	37.5%
		Lyons Bay Seal Island Western Granite		9	90.0%	1	10.0%
MOROCCO		Zaer		92	76.0%	29	24.0%
		Ment		8	53.3%	7	46.7%
		Oulmes		5	83.3%	1	16.7%
		Sebt de Brikiine		6	42.9%	8	57.1%
		Ajar El Bark		2	66.7%	1	33.3%
		Tabouchennt-Bamega		8	100.0%	0	0.0%
		Oulad Ouaslam		18	100.0%	0	0.0%
		Tichka		-	- %	-	- %

Discriminant Function

Sr	1.23845
MgO	-1.06681
Rb	0.75486
CaO	0.74029
Na_2O	-0.70413
Al_2O_3	0.47063
Ba	-0.44260
K_2O	0.16886
TiO_2	-0.15365
Fe_2O_{3t}	0.14997

Classification Matrix

			Predicted Group	
			N.S	Morocco
Actual Group	N.S.	337	283 84.0%	54 16.0%
	Morocco	185	46 24.9%	139 75.1%

Total Correctly Classified 80.84%

Figure 5.10. Discriminant function, detailed and summary classification matrix for Model 4.

Misclassification of samples is also occuring within Nova Scotia. Particularly from the Ellison lake pluton of southern Nova Scotia with 100 % being misclassified into the Moroccan group. In addition samples from the Sherbrooke pluton (north), and the Moose Point pluton (south) show remarkable similarity with the Moroccan population.

All samples from the Jebilet Massif of Morocco are correctly classified in the model suggesting that the Jebilet granites are geochemically distinct from the Nova Scotian granites. The misclassification of the Rehamna granites is interesting. Geological evidence seems to suggest (see Chapter 2) that of all the Moroccan granites they appear to be the least similar to Nova Scotia. In particular most characteristic peraluminous minerals are absent in the plutons, and their Permian age represents the widest age gap with the Nova Scotian granites (this may support the assumption that age is of minimal consequence). It is difficult to attribute a meaning to their misclassification because of the limited number of variates used in the calculation. This problem will be readdressed later in this section as more elements are added to subsequent Models.

5.6.3 Model 5 (Nova Scotia - Morocco)

5.6.3.1 Results of Model 5 (Nova Scotia - Morocco)

In a second run of the Nova Scotian and Moroccan granites (Model 5) P_2O_5 was added to the list of variables from Model 4. Figure 5.11 illustrates the frequency distribution of the discriminant scores for the two groups. The discriminant function and classification matrix are presented in Table 5.12. A detailed listing of the classification matrix for each pluton is also presented in Figure 5.12.

MgO, Sr, Rb, Na_2O, Al_2O_3, P_2O_5, and CaO have absolute coefficient values greater than 0.4 and are considered important discriminators in this function; Ba, Fe_2O_{3t}, TiO_2, and K_2O are of lesser importance. The

Model 5 - Nova Scotia - Morocco

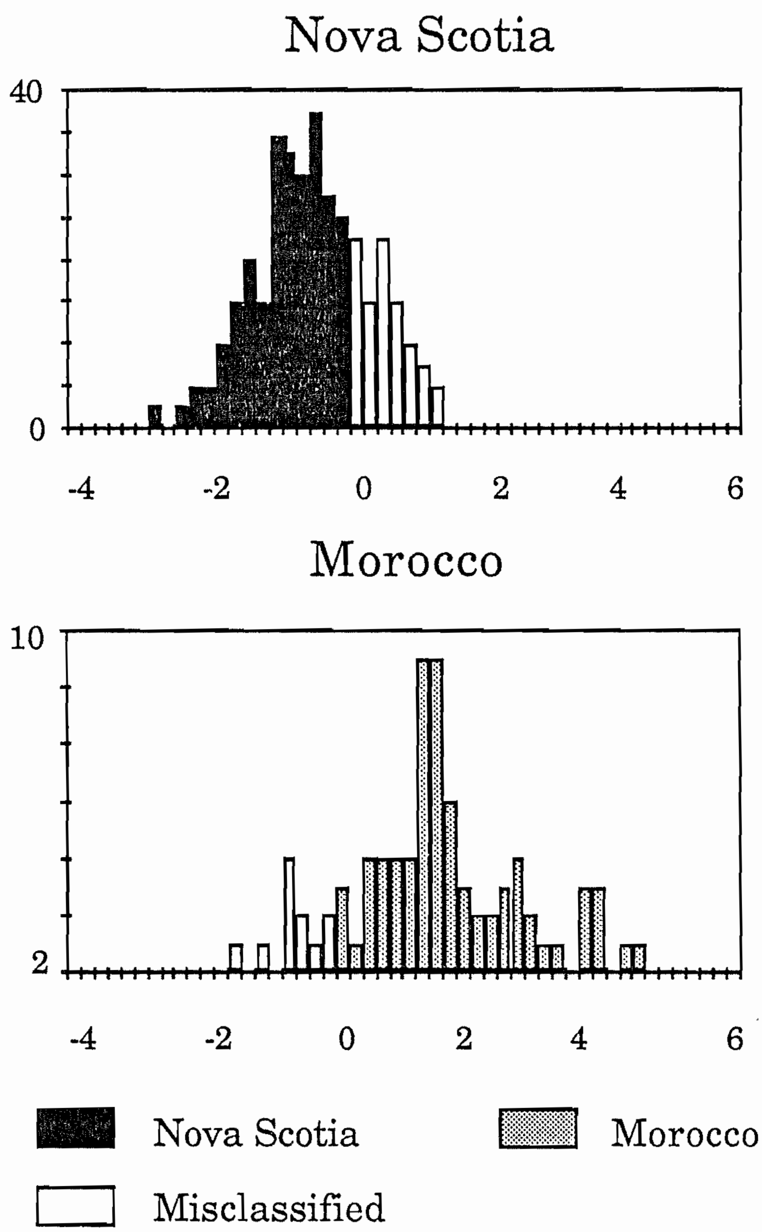


Figure 5.11. Frequency plot of discriminant scores from Model 5.

Model 5 - Nova Scotia - Morocco

Detailed Classification Matrix

		GRANITE		CORRECTLY CLASSIFIED		MISCLASSIFIED	
NOVA SCOTIA	North	SMB	Charest	16	94.1%	1	5.9%
		SMB	McKenzie	13	72.2%	5	27.8%
		SMB	Smith	26	81.3%	6	18.7%
		SMB	Richardson	4	50.0%	4	50.0%
		Musquodoboit		9	90.0%	1	10.0%
		Liscomb		9	100.0%	0	0.0%
		Sherbrooke		11	64.7%	6	35.3%
		Bull Ridge		12	100.0%	0	0.0%
		Sangster Lake & Larry's River		30	93.8%	2	6.2%
		Queensport & Halfway Cove		28	77.8%	8	22.2%
		Ellison Lake		2	14.3%	12	85.7%
	South	Barrington Passage		27	87.1%	4	12.9%
		Shelburne		26	96.3%	1	3.7%
		Bald Mountain		4	100.0%	0	0.0%
		Port Mouton		44	84.6%	8	15.4%
		Moose Point		8	100.0%	0	0.0%
		Lyons Bay, Seal Island, Western Granite		10	100.0%	0	0.0%
MOROCCO		Zaer		21	60.0%	14	40.0%
		Ment		3	100.0%	0	0.0%
		Oulmes		-	- %	-	- %
		Sebt de Brikiine		13	92.9%	1	7.1%
		Ajar El Bark		3	100.0%	0	0.0%
		Tabouchennt-Bamega		8	100.0%	0	0.0%
		Oulad Ouaslam		18	100.0%	0	0.0%
		Tichka		-	- %	-	- %

Discriminant Function

MgO	-1.31727
Sr	1.16580
Rb	0.75380
Na_2O	-0.61486
Al_2O_3	0.58987
P_2O_5	-0.49626
CaO	0.43934
Ba	-0.38912
Fe_2O_{3t}	0.29879
TiO_2	0.03925
K_2O	0.01124

Classification Matrix

			Predicted Group	
			N.S	Morocco
Actual Group	N.S.	337	277 82.2%	60 17.8%
	Morocco	81	15 18.5%	66 81.5%

Total Correctly Classified 82.06%

Figure 5.12. Discriminant function, detailed and summary classification matrix for Model 5.

classification matrix indicates that 82.06 % (S_e = 1.88 %) of all cases are correctly classified during the analysis.

5.6.3.2 Discussion of Model 5 (Nova Scotia - Morocco)

The addition of P_2O_5 may account for the slight improvement in the discrimination between both areas. As in Model 4, some elements appear to be particularly good regional discriminators (i.e. MgO, Na_2O and Al_2O_3). Samples from the Rehamna Massif are no longer misclassified in the calculations evidently as a result of the inclusion of P_2O_5 in the analysis. These results indicate that P_2O_5 populations are different in both areas. P_2O_5 populations are also variable within Morocco i.e. the Rehamna granites are no longer being misclassified while the Zaer pluton is still being misclassified.

Generally, significant amounts of samples from the Ellison Lake, SMB, and Sherbrooke plutons of Nova Scotia are misclassified into the Moroccan group. In Morocco, only the Zaer granites (Central Massif) appear similar to the Nova Scotian granites.

5.6.4 Model 6 (Nova Scotia - Morocco)

5.6.4.1 Results of Model 6 (Nova Scotia - Morocco)

A third run (Model 6) was done with SiO_2 - Al_2O_3 - MgO - CaO - Na_2O - Ba - Rb - Sr - V. The frequency distributions of the discriminant scores are shown in Figure 5.13. The discriminant function and classification matrix are presented in Figure 5.14. A detailed listing of the classification matrix for each pluton is presented in Figure 5.14.

Sr, MgO, Rb, CaO, V, Na_2O are important discriminators in the function. Ba and Al_2O_3 are of lesser importance. The classification matrix shows that 87.45 (S_e = 2.11 %) of all cases have been correctly classified.

Model 6 - Nova Scotia - Morocco

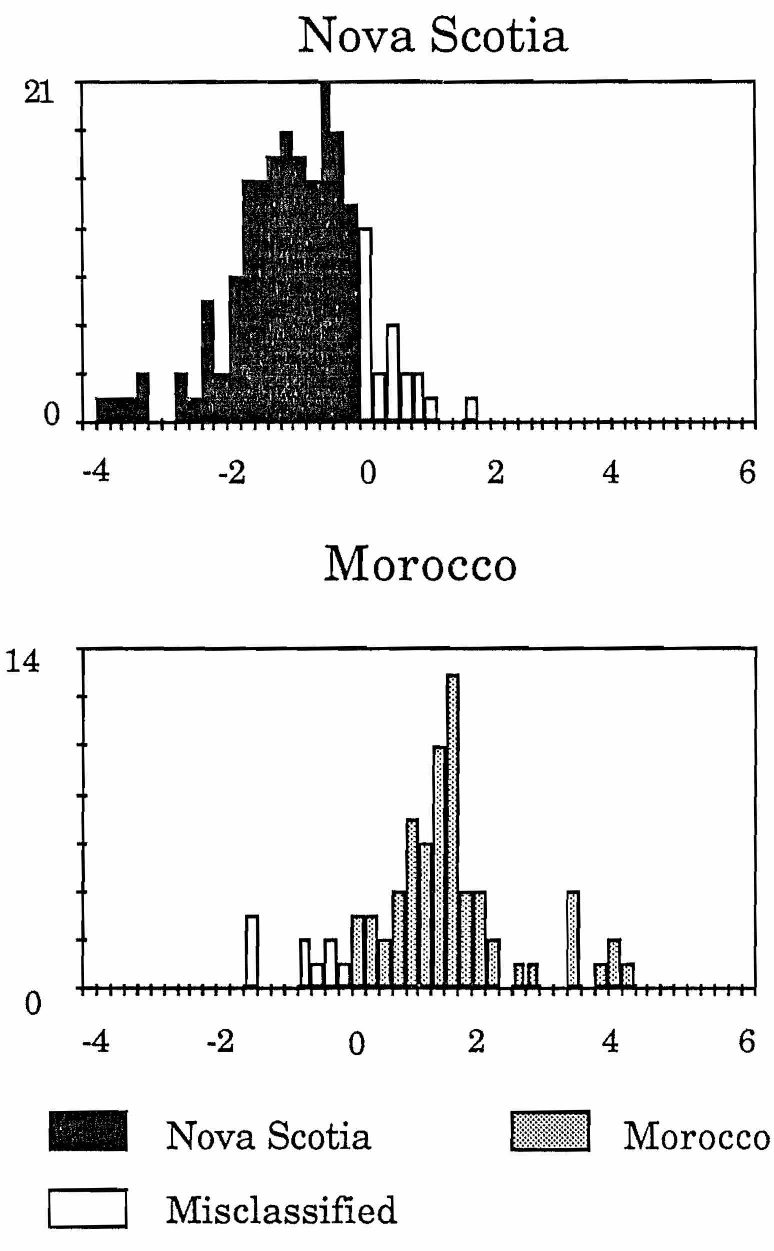


Figure 5.13. Frequency plot of discriminant scores from Model 6.

Model 6 - Nova Scotia - Morocco

Detailed Classification Matrix

Region	Area	Granite		Correctly Classified		Misclassified	
NOVA SCOTIA	North	SMB	Charest	-	- %	-	- %
		SMB	McKenzie	-	- %	-	- %
		SMB	Smith	24	75.0%	8	25.0%
		SMB	Richardson	3	75.0%	1	25.0%
		Musquodoboit		-	- %	-	- %
		Liscomb		8	100.0%	0	0.0%
		Sherbrooke		4	80.0%	1	20.0%
		Bull Ridge		-	- %	-	- %
		Sangster Lake & Larry's River		-	- %	-	- %
		Queensport & Halfway Cove		20	95.2%	1	4.8%
		Ellison Lake		-	- %	-	- %
	South	Barrington Passage		20	86.9%	3	13.1%
		Shelburne		18	85.7%	3	14.3%
		Bald Mountain		3	100.0%	0	0.0%
		Port Mouton		42	95.4%	2	4.5%
		Moose Point		-	- %	-	- %
		Lyons Bay, Seal Island, Western Granite		9	100.0%	0	0.0%
MOROCCO		Zaer		30	85.7%	5	14.3%
		Ment		4	80.0%	1	20.0%
		Oulmes		-	- %	-	- %
		Sebt de Brikiine		5	55.6%	4	44.4%
		Ajar El Bark		-	- %	-	- %
		Tabouchennt-Bamega		8	100.0%	0	0.0%
		Oulad Ouaslam		17	100.0%	0	0.0%
		Tichka		-	- %	-	- %

Discriminant Function

Sr	1.53573
MgO	-1.26787
Rb	1.07485
CaO	0.71022
V	0.62819
Na_2O	-0.59992
Ba	-0.51128
Al_2O_3	0.03239

Classification Matrix

			Predicted Group	
			N.S	Morocco
Actual Group	N.S.	170	151 88.8%	19 11.2%
	Morocco	77	12 15.6%	65 84.4%

Total Correctly Classified 87.45%

Figure 5.14. Discriminant function, detailed and summary classification matrix for Model 6.

5.6.4.2 Discussion of Model 6 (Nova Scotia - Morocco)

Although the number of correctly classified samples appears high when the results are compared with other models (Model 4 = 80.84 $\pm$ 3.14, Model 5 = 82.06 $\pm$ 3.76 and this Model 6 = 87.45 $\pm$ 4.27) overlap does exist therefore these Models cannot be considered significantly different.

Some data vectors from the Central and Rehamna Massifs are being misclassified during the analyses. However, as demonstrated in Model 5, the addition of P_2O_5 to the variable list, will allow discrimination between these two massifs. P_2O_5 was not included in the analyses because of restrictions resulting from the limited number of cases.

5.6.5 Discussion of the Nova Scotia- Morocco Models

The following observations can be made on the three models presented in this section:

1) The Nova Scotian and Moroccan granites can not be characterized as geochemicaly distinct based on the limited number of variates used in the analysis.

2) Sr, MgO, Rb, CaO, Na_2O, V, P_2O_5, Al_2O_3, and Ba show the most variation between Nova Scotia and Morocco (Figure 5.15).

3) The Zaer pluton of the Central Massif appears to present more geochemical similarities with the Nova Scotian granites than any other granite within Morocco. It is particularly interesting to note that the Zaer pluton was intruded within Ordovician Flysch, like the Nova Scotian granites.

4) Some elements can be defined as good regional discriminators (Nova Scotia- Morocco) while others appear more variable at the local scale (North-South, Nova Scotia).

5.7 Nova Scotia - Morocco - Iberia

5.7.1 Introduction

Results of discriminant analysis on the Nova Scotian and Moroccan granites suggested that these granites could not be characterized as clearly distinct and seemingly present some geochemical similarities. The significance of these results needs to be assessed. To do this another potential area for correlation needed to be investigated. Consequently Iberian peraluminous granites were included in the analysis to determine whether the results are characteristic of the Nova Scotian and Moroccan granites or if similar results might be obtained when another Hercynian population is considered.

5.7.2 Model 7 Nova Scotia - Morocco - Iberia

5.7.2.1 Results of Model 7 (Nova Scotia, Morocco, Iberia)

Model 7 was run using SiO_2 - TiO_2 - Al_2O_3 - Fe_2O_{3t} - MgO - CaO - Na_2O - K_2O - Ba - Rb - Sr. A scatter plot of the discriminant scores is given in Figure 5.16. A territorial map delimiting the various group domains was drawn on Figure 5.16. The two discriminant functions and the classification matrix are presented in Figure 5.17. Function 1 accounts for 60.79 % of the total variation and function 2, 30.21 %. These values indicate the importance of each function in the total discrimination. Analysis of the discriminant functions shows that MgO, Sr, Rb, Na_2O, Fe_2O_{3t}, and CaO are important discriminators. TiO_2, Ba, Al_2O_3, K_2O are of lesser importance. The classification matrix shows that 60.69 % of all cases were correctly classified (with a S_e = 1.74 %). The reader will note that in these 3 group models identical populations are indicated by a correct classification result of 33 % as opposed to 50 % in the previous 2 group models.

Nova Scotia - Morocco Models

Absolute Coefficient Value	**Model 4**	**Model 5**	**Model 6**
$C > 0.8$	Sr MgO	MgO Sr	Sr MgO Rb
$0.8 > C > 0.6$	Rb CaO Na_2O	Rb Na_2O	CaO V
$0.6 > C > 0.4$	Al_2O_3 Ba	Al_2O_3 P_2O_5 CaO	Na_2O Ba
$0.4 > C > 0.2$		Ba Fe_2O_{3t}	
$0.2 > C > 0.0$	K_2O TiO_2 Fe_2O_{3t}	TiO_2 K_2O	Al_2O_3

Significant Discriminator (rows $C > 0.8$ to $0.6 > C > 0.4$)

Discriminator of Less Significance (rows $0.4 > C > 0.2$ and $0.2 > C > 0.0$)

Figure 5.15. Generally Sr, MgO, Rb, CaO, Na_2O, V, Al_2O_3, and Ba are the most significant discriminators between Nova Scotia and Morocco.

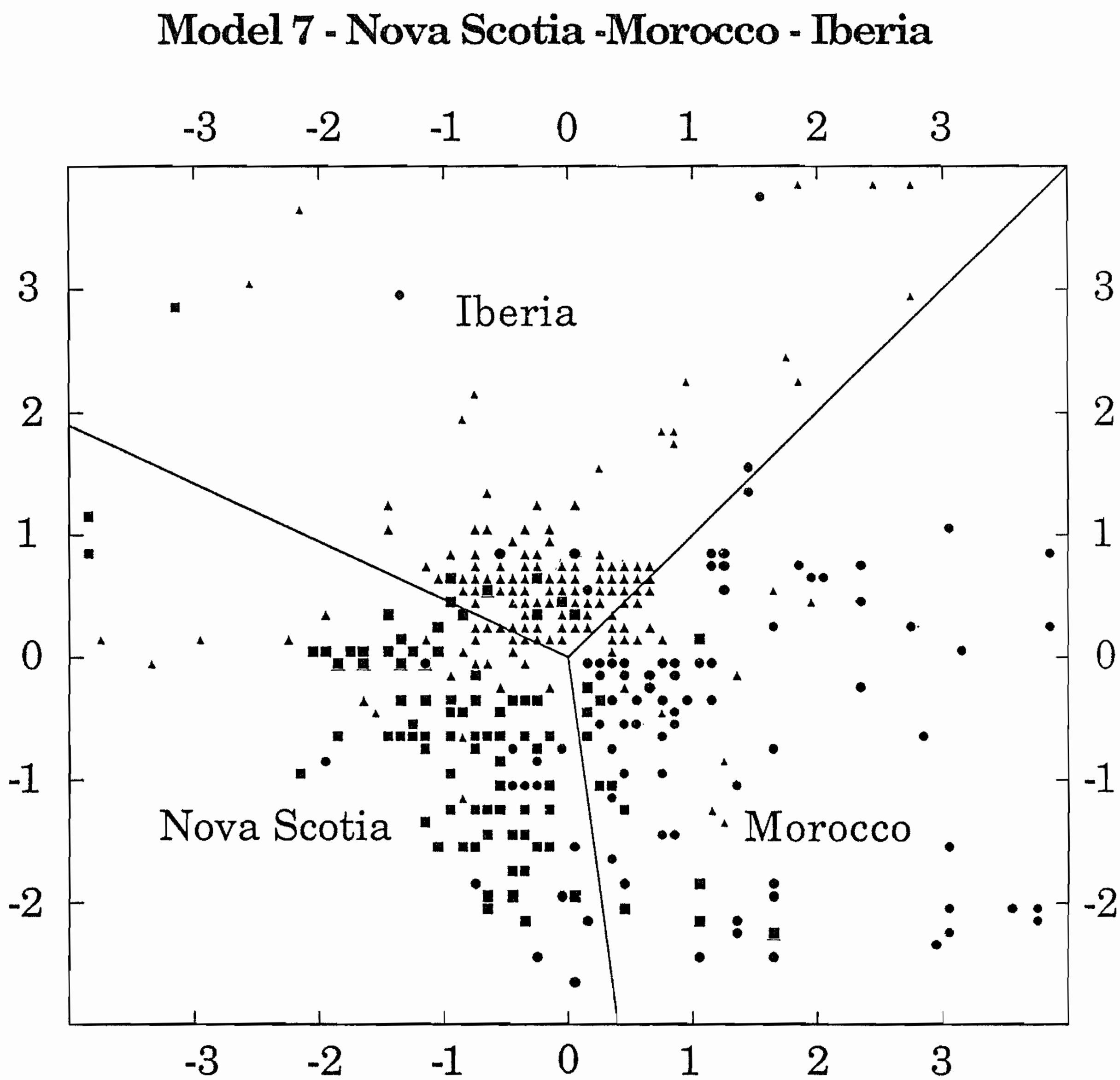


Figure 5.16. Scatter plot and territorial map of discriminant scores from Model 7.

Model 7 - Nova Scotia - Morocco - Iberia

Discriminant Functions

	Function 1	Function 2
Sr	1.37301	-0.17214
MgO	-1.16372	1.51257
Rb	0.84938	0.68103
Na_2O	-0.56679	-0.44581
Fe_2O_{3t}	0.55137	-0.60974
CaO	0.40303	-0.36934
TiO_2	-0.38145	0.14793
Ba	-0.32686	-0.06713
Al_2O_3	0.32610	-0.20805
K_2O	0.12770	-0.20307

	Eigenvalue	Percent of Variance
Function 1	0.83614	71.09
Function 2	0.21222	22.00

Classification Matrix

			Predicted Group		
			N.S	Morocco	Iberia
Actual Group	N.S.	337	210 62.3%	43 12.8%	84 24.9%
	Morocco	185	40 21.6%	111 60.0%	34 18.4%
	Iberia	264	62 23.5%	46 17.4%	156 59.1%

Total Correctly Classified 60.69%

Figure 5.17. Discriminant functions, eigenvalues and classification matrix for Model 7.

5.7.2.2 Discussion of Model 7 (Nova Scotia, Morocco, Iberia)

The classification matrix in Model 7 indicates that the Nova Scotian population is being misclassified into the Iberian populations twice as often as into the Moroccan populations. This suggests that the Nova Scotian granites are more similar to the Iberian granites than the Moroccan granites. Upon scrutuny of the detailed classification matrix (not shown here) it becomes evident that the distinctive nature of the granites from the southern part of Morocco are the reason why the Moroccan granites are not as well correlated with the Nova Scotian granites. In effect the northern granites of Morocco (Central and Rehamna Massifs) and the Iberian granites are equally similar to the Nova Scotian granites.

5.7.3 Model 8 Nova Scotia - Morocco - Iberia

5.7.3.1 Results of Model 8 (Nova Scotia, Morocco, Iberia)

Model 8 was run using SiO_2 - TiO_2 - Al_2O_3 - Fe_2O_{3t} - MgO - CaO - Na_2O - K_2O - P_2O_5 - Ba - Rb - Sr. A scatter plot of the discriminant score results and a territorial map of each group is shown on Figure 5.18. The discriminant functions and classification results are given in Figure 5.19. The classification matrix shows that 68.12 % of all cases were correctly classified with a S_e of 1.81 %.

5.7.3.2 Discussion of Model 8 (Nova Scotia, Morocco, Iberia)

As in Model 7 the Nova Scotian population is being misclassified into the Iberian population twice as often as into the Moroccan populations. The addition of P_2O_5 in the Model has eliminated the Rehamna in the misclassified samples. In this model the northern granites of Morocco (Central Massif, Zaer pluton in particular) and the Iberian granites are equally similar to Nova Scotia.

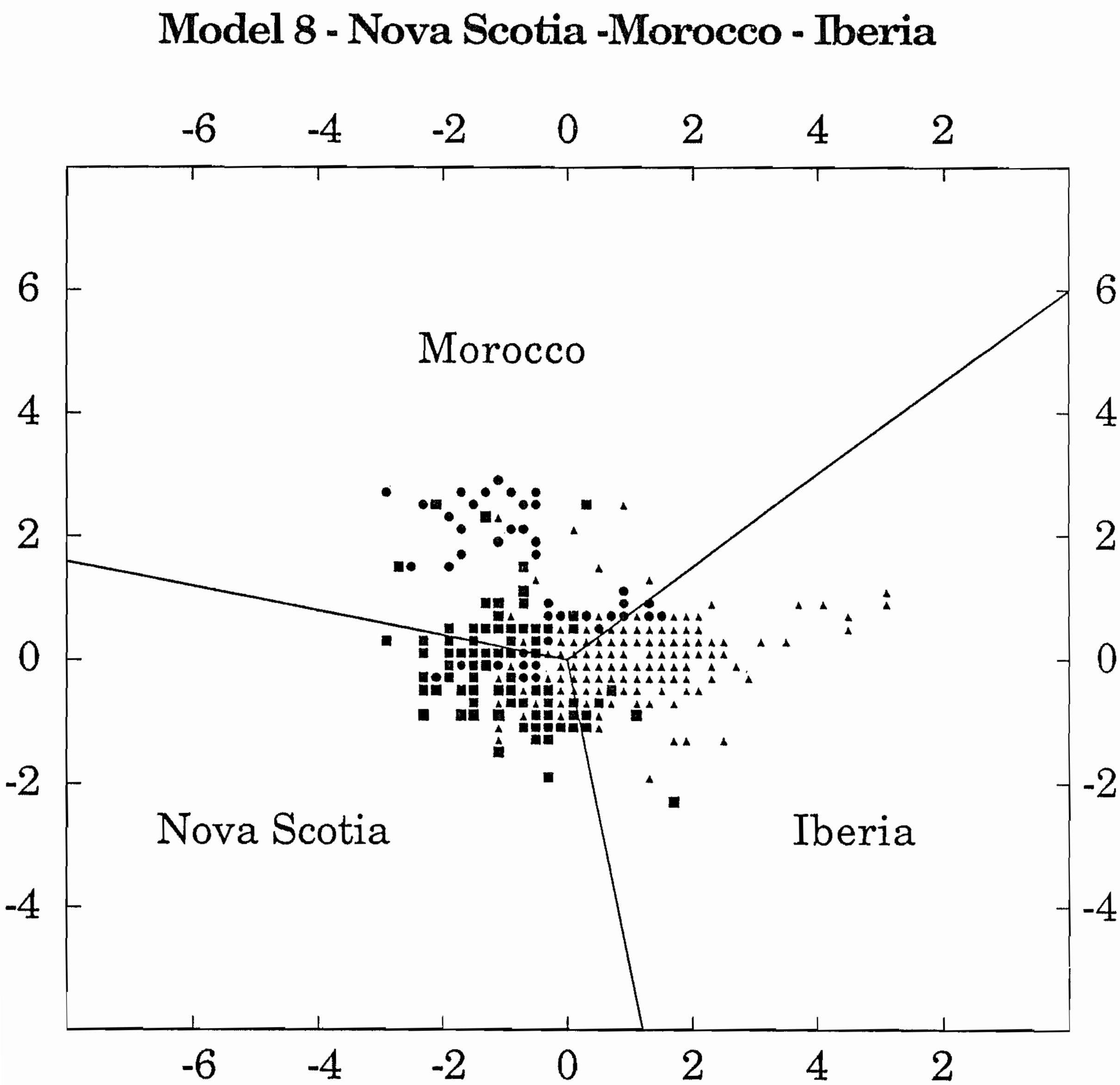


Figure 5.18. Scatter plot and territorial map of discriminant scores from Model 8.

Model 8 - Nova Scotia - Morocco - Iberia

Discriminant Functions

	Function 1	Function 2
Rb	1.13963	0.48297
MgO	1.10553	-1.75698
Na_2O	-0.64409	-0.37710
Fe_2O_{3t}	-0.57660	0.88458
Sr	0.41701	0.99108
P_2O_5	-0.35913	-0.37510
Ba	-0.17339	-0.14015
Al_2O_3	0.14148	0.19968
K_2O	-0.09712	0.10375
CaO	-0.06603	0.35598
TiO_2	0.03662	-0.00511

	Eigenvalue	Percent of Variance
Function 1	0.40805	56.79
Function 2	0.31044	43.21

Classification Matrix

			Predicted Group		
			N.S	Morocco	Iberia
Actual Group	N.S.	337	228 67.7%	44 13.1%	65 19.3%
	Morocco	81	12 14.8%	51 63.0%	18 22.2%
	Iberia	247	61 24.7%	12 4.9%	174 70.4%

Total Correctly Classified 68.12%

Figure 5.19. Discriminant functions, eigenvalues and classification matrix for Model 8.

5.8 Nova Scotia-Morocco-Iberia-Australia

5.8.1 Introduction

Previous statistical models presented in this chapter suggested some geochemical similarities between the Acadian/Hercynian granites of Nova Scotia, Morocco and Iberia. A question arises as to the significance of the analysis. Particularly are all peraluminous granites the same worldwide. To answer this question the Nova Scotian, Moroccan and Iberian granites were compared with peraluminous granites Australia of similar age and composition, but of an unrelated orogenic belt.

5.8.2 Model 9 (Nova Scotia - Morocco - Iberia - Australia)

5.8.2.1 Results of Model 9 (Nova Scotia, Morocco, Iberia, Australia)

A first model was run using SiO_2 - TiO_2 - Fe_2O_{3t} - MgO - CaO - Na_2O - K_2O - P_2O_5. The frequency distribution of the discriminant scores is shown in Figure 5.20. The discriminant function and classification matrix are given in Figure 5.21.

CaO, Al_2O_3, Na_2O, TiO_2 are important discriminators in the function and MgO to a lesser degree. With a percentage of correctly classified cases at 92.08 %, the two populations do in fact appear to be geochemicaly different (S_e = 0.88 %).

5.8.2.2 Discussion of Model 9 (Nova Scotia, Morocco, Iberia, Australia)

The importance of CaO in the discriminant function of Model 9 reflects the significantly higher concentration of CaO in the Australian granites relative to the Acadian/Hercynian granites. The Australian granites are also characterised by their slightly lower Al_2O_3, Na_2O and higher TiO_2 values.

Model 9 - Atlantic - Australia

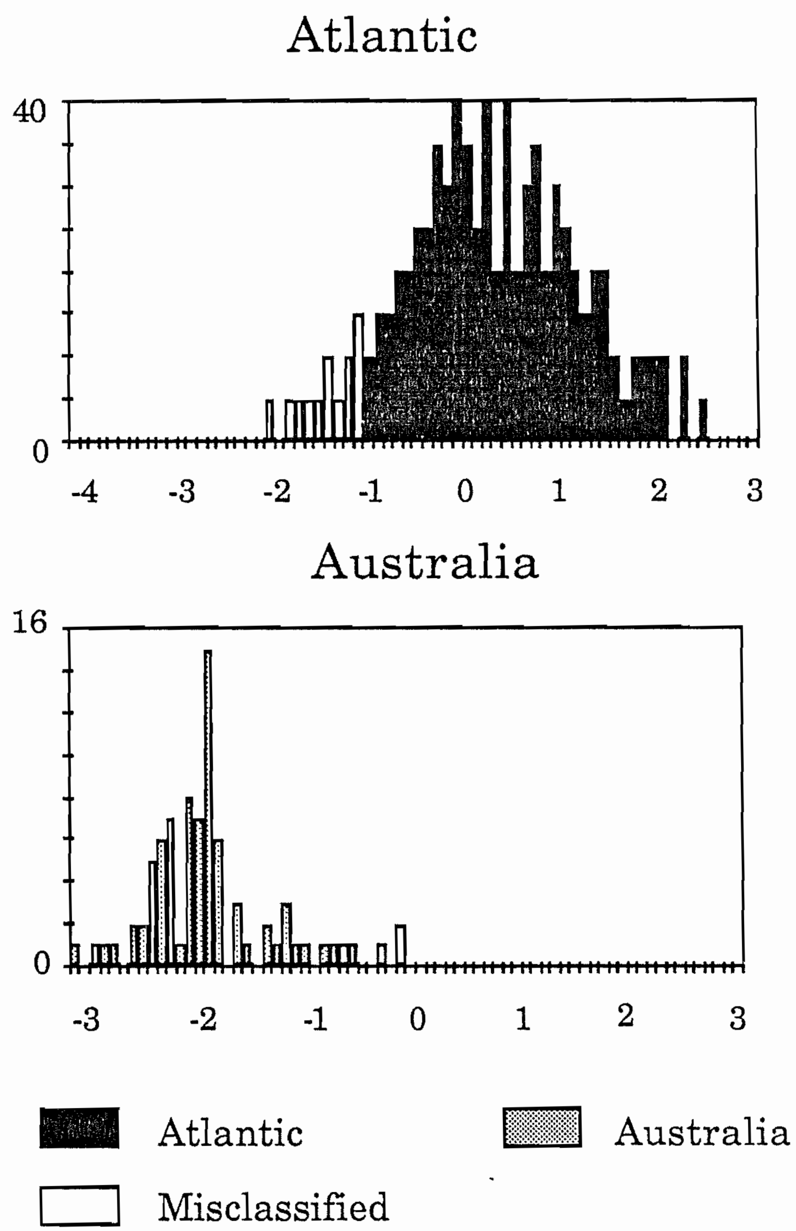


Figure 5.20. Frequency plot of discriminant scores from Model 9.

Model 9 - Nova Scotia - Morocco - Iberia - Australia

Discriminant Function

CaO	-1.40157
Al_2O_3	0.95117
Na_2O	0.84547
TiO_2	0.44212
MgO	-0.25003
Fe_2O_{3t}	0.12494
P_2O_5	-0.09584
K_2O	0.00133

Classification Matrix

			Predicted Group	
			Herc.	Austr.
Actual Group	Herc.	787	728 92.5%	59 7.5%
	Austr.	102	7 6.9%	95 93.1%

Total Correctly Classified 92.58%

Figure 5.21. Discriminant functions and classification matrix for Model 9.

5.8.3 Models 10 and 11 Nova Scotia - Morocco - Iberia - Australia

5.8.3.1 Results and Discussion of Models 10 and 11 (Nova Scotia, Morocco, Iberia, Australia)

The discriminant function and classification results of two additional models are presented in Figure 5.22. Although these two runs do not present the appropriate number of cases in the Australian group, they do however indicate that the addition of Ba, Rb and Sr to these models do not contribute significantly to the discrimination.

5.8.4 Model 12 Nova Scotia - Morocco - Iberia - Australia

5.8.4.1 Results of Model 12 (Nova Scotia, Morocco, Iberia, Australia)

In this model the four populations were evaluated separately in the Model. This was done to determine whether the Hercynian granites were equally different from the Australia population. Model 12 included the following variates: TiO_2, Al_2O_3, Fe_2O_{3t}, MgO, CaO, Na_2O, K_2O, and P_2O_5. Again CaO, Al_2O_3, Na_2O and Ti_2O are important discriminators.

5.8.4.2 Discussion of Model 12 (Nova Scotia, Morocco, Iberia, Australia)

The classification matrix of Figure 5.24 clearly indicates the difference between the Atlantic and Australian populations. Although the Atlantic granites present similar classification values amongst themselves (correctly classified between 54-61%) they are very seldom misclassified into the Australian population. The Australian population are distinct with a value of 92.2% for correctly classified cases (S_e = 1.66 %). The Australian granites are also rarely misclassified into the Atlantic populations. Therefore, the Hercynian/Acadian granites are clearly different from the Australian granites.

Model 10 and 11 - Nova Scotia + Morocco + Iberia - Australia

Model 10

Discriminant Function

CaO	-1.38553
Al_2O_3	0.91585
Na_2O	0.82037
MgO	-0.55969
TiO_2	0.38933
Rb	-0.21136
Fe_2O_{3t}	0.18877
Ba	0.18227

Classification Matrix

			Predicted Group	
			Atla.	Austr.
Actual Group	Herc.	800	761 95.1%	39 4.9%
	Austr.	80	5 6.3%	75 93.8%

Total Correctly Classified 95.00%

Model 11

Discriminant Function

CaO	-1.51801
Na_2O	0.92519
Al_2O_3	0.89607
TiO_2	0.40502
MgO	-0.38492
Rb	-0.34015
Fe_2O_{3t}	0.21389
Ba	0.17591
Sr	-0.14569
P_2O_5	-0.08779
K_2O	0.01576

Classification Matrix

			Predicted Group	
			Atla .	Austr.
Actual Group	Herc.	665	634 95.3%	31 4.7%
	Austr.	80	3 3.7%	77 96.2%

Total Correctly Classified 95.44%

Figure 5.22. Discriminant functions and classification matrices for Models 10 and 11.

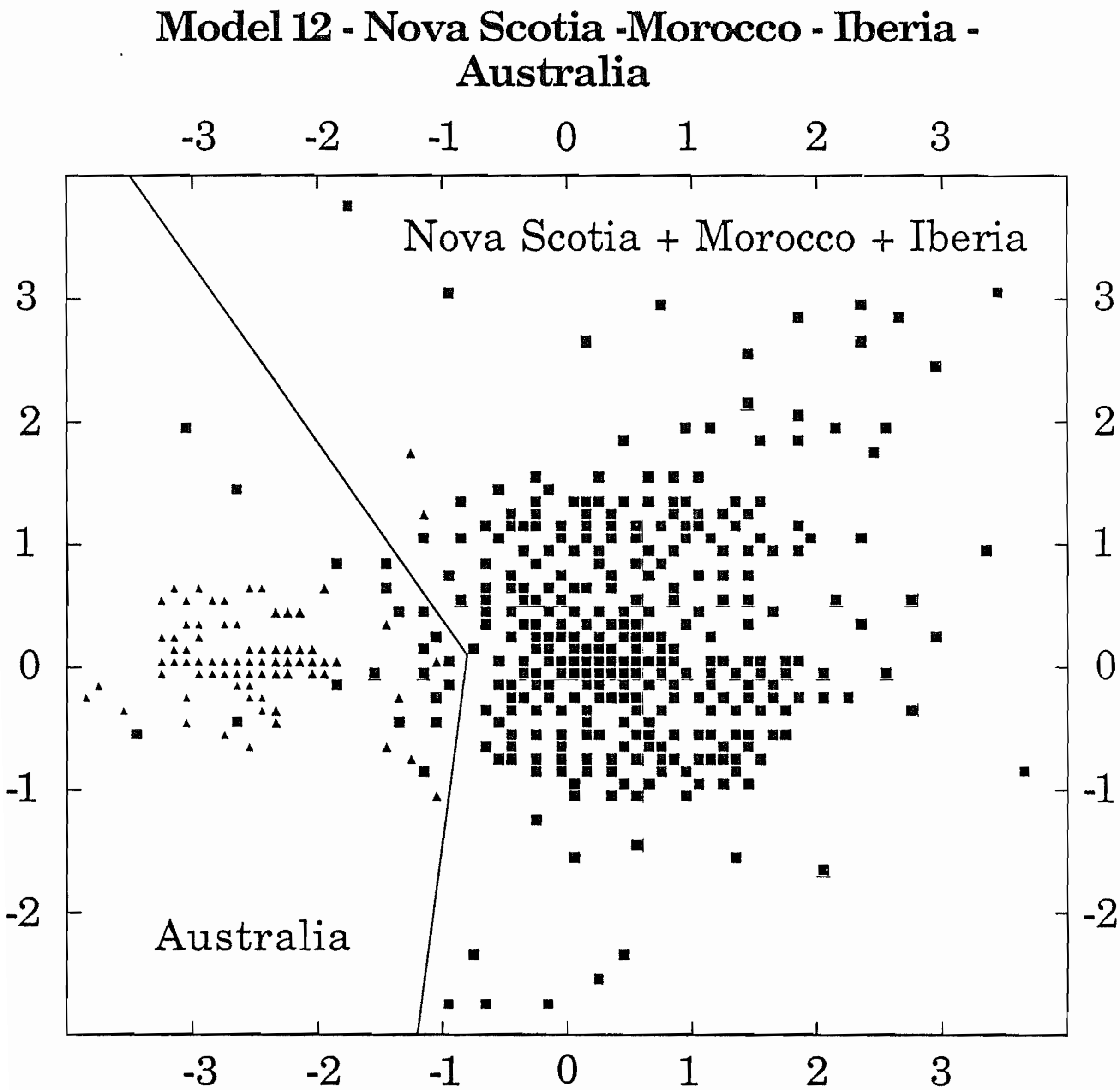


Figure 5.23. Scatter plot and territorial map of discriminant scores from Model 12.

Model 12 - Nova Scotia + Morocco + Iberia - Australia

Discriminant Functions

	Function 1	Function 2	Function 3
CaO	-1.42977	0.58000	0.62038
Al_2O_3	0.88204	-0.26101	0.78786
Na_2O	0.83798	0.47216	-0.27583
TiO_2	0.38086	-0.46879	0.55568
Fe_2O_{3t}	0.15473	0.86051	-0.3552
MgO	-0.13146	-1.02501	-1.60567
P_2O_5	-0.05000	0.28654	-0.40104
K_2O	-0.03950	-0.07006	0.41490

	Eigenvalue	Percent of Variance
Function 1	0.83614	71.09
Function 2	0.24133	20.52
Function 3	0.09869	8.39

Classification Matrix

			Predicted Group			
			N.S	Morocco	Iberia	Austr.
Actual Group	N.S.	333	209 54.6%	66 22.5%	77 20.1%	11 2.9%
	Morocco	107	22 21.6%	58 54.2%	17 15.9%	10 9.3%
	Iberia	297	51 17.2%	47 15.8%	181 60.9%	18 6.1%
	Austr.	102	0 0.0%	6 5.9%	2 2.0%	94 92.2%

Total Correctly Classified 60.97%

Figure 5.24. Discriminant functions, eigenvalues and classification matrix for Model 12.

5.8.5 Model 13 and 14 Nova Scotia - Morocco - Iberia - Australia

5.8.5.1 Results and discussion of Models 13 and 14 (Nova Scotia, Morocco, Iberia, Australia)

The discriminant function and classification results of two additional models are presented in Figure 5.25. As for Models 10 and 11 these two runs do not present the appropriate number of cases in the Australian group. There is an apparent increase in the importance of Ba, Rb and Sr as relative to models 10 and 11 however, it is difficult to characterise there importance in the discrimination.

5.8.6 Discussion of the Nova Scotian - Moroccan - Iberian - Australian Models

The following observations can be made on the models presented in this section:

1) The Atlantic granites and the Australian granites are in effect geochemically distinct.

2) Some elements appear to be good discriminators on the orogenic scale.

3) These models confirm that all peraluminous granites worldwide are not the same.

Model 13 - Nova Scotia + Morocco + Iberia - Australia

Discriminant Functions

	Function 1	Function 2	Function 3
CaO	-1.30471	-0.40407	1.08357
Al_2O_3	0.88246	0.51205	0.66659
Na_2O	0.83159	-0.33081	-0.28556
MgO	-0.69648	0.53493	-1.89520
TiO_2	0.36526	0.12714	-0.38818
Rb	-0.30668	0.88576	0.44581
Fe_2O_{3t}	0.26151	0.53493	0.68233
Ba	0.18190	0.14639	0.46583

	Eigenvalue	Percent of Variance
Function 1	0.77751	69.81
Function 2	0.17710	15.90
Function 3	0.15909	14.28

Classification Matrix

			Predicted Group			
			N.S	Morocco	Iberia	Austr.
Actual Group	N.S.	350	165 52.9%	58 19.4%	92 26.3%	5 1.4%
	Morocco	186	43 23.1%	94 50.5%	42 22.6%	7 3.8%
	Iberia	264	48 18.2%	49 18.6%	148 56.1%	19 7.2%
	Austr.	80	2 2.5%	2 2.5%	1 1.2%	75 93.8%

Total Correctly Classified 57.05%

Figure 5.25. Discriminant functions, eigenvalues and classification matrix for Model 13.

Model 14 - Nova Scotia + Morocco + Iberia - Australia

Discriminant Functions

	Function 1	Function 2	Function 3
CaO	1.30884	-0.80106	-0.58002
Na_2O	-0.98728	0.04278	-0.23219
Al_2O_3	-0.70974	0.80922	0.71967
Rb	0.68321	0.49561	0.90047
MgO	0.50836	1.80734	-0.93220
Sr	0.34969	-0.31349	0.96984
TiO_2	-0.33645	0.17361	0.24143
Fe_2O_{3t}	-0.28737	-0.93500	0.46932
Ba	-0.21457	0.02731	-0.12014
P_2O_5	-0.07576	-0.09295	-0.57064
K_2O	-0.03238	-0.12651	0.03337

	Eigenvalue	Percent of Variance
Function 1	1.03990	63.35
Function 2	0.32747	19.95
Function 3	0.27417	16.70

Classification Matrix

			Predicted Group			
			N.S	Morocco	Iberia	Austr.
Actual Group	N.S.	337	226 67.1%	44 13.1%	63 18.7%	4 1.2%
	Morocco	81	11 13.6%	50 61.7%	15 18.5%	5 6.2%
	Iberia	247	59 23.9%	12 4.9%	163 66.0%	13 5.3%
	Austr.	80	1 1.2%	3 3.7%	1 1.2%	75 93.8%

Total Correctly Classified 68.99%

Figure 5.26. Discriminant functions, eigenvalues and classification matrix for Model 14.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

6.1 Conclusions

Comparison of the stratigraphy of the Meguma Terrane of Nova Scotia and Paleozoic Massifs of Morocco shows similarity in their Cambrian to Carboniferous successions, and provides justification for this study.

A comparison of the major, trace, and rare earth element data using traditional approaches has revealed that:

1- The geochemical populations of the northern and southern plutons of Nova Scotia, although apparently different, cannot be clearly separated into two groups.

2- The Nova Scotian and Moroccan geochemical populations could not be separated and, in effect, appear indistinguishable.

3- In addition, limited Nd and Sr isotopic data also suggest some similarity between both areas.

The applicability of discriminant analysis to granitic data was demonstrated using various test models. In particular, results show that:

1- Discriminant analysis of compositional geochemical data can be successfully applied using the log ratio transformation to eliminate the closure problem.

2- Bimodal and moderately skewed populations and uneven sample groups (up to 10:1) can be successfully analysed using discriminant function analysis.

3- The reliability of the discriminant coefficients was also demonstrated indicating that the contribution of the different variates (elements, oxides) to the discrimination could be interpreted.

Based on the statistical models the following conclusions can be made:

1- The results confirm geological observations made by previous workers that suggested that the granites from Northern and Southern Nova Scotia were different. In addition, the discriminant analysis also allows the classification of samples using the discriminant function. In the models some elements are consistently excellent discriminators within Nova Scotia (Rb, Sr, Ba, TiO_2, CaO and, Pb).

2- The Nova Scotian and Moroccan models suggest that the two groups can not be characterized as geochemically distinct. The Zaer pluton of the Central Massif appears to show more geochemical similarities with the Nova Scotian granites than any other granite within Morocco. All Ellison Lake specimens from Nova Scotia are misclassified into the Moroccan population. Variables such as Sr, MgO, Rb, CaO, Na_2O, V, P_2O_5, Al_2O_3 and, Ba show the most the most variation between Nova Scotia and Morocco.

3- The Nova Scotian, Moroccan and Iberian models indicate that the granites of Morocco (Central Massif, Zaer pluton in particular) and the Iberian granites are equally similar to Nova Scotia. As in the Nova Scotian- Moroccan models, Sr, MgO, Rb, Na_2O, CaO, and P_2O_5 are good discriminators, however, Fe_2O O_{3t} is much more important in the Nova Scotia-Morocco-Iberia models than in the Nova Scotia-Morocco ones.

4- The models comparing the Atlantic and Australian granites indicate that the two groups are in effect geochemically distinct. Variables such as CaO, Al_2O_3, Na_2O, MgO, and TiO_2 show the most variation between these two orogenic belts.

5- Comparison of results obtained on the local (north-south Nova Scotia), regional (Nova Scotia-Morocco and Nova Scotia-Morocco-Iberia) and the orogenic scale (Atlantic and Australian granites) show that different suites of elements can be characterised as good discriminators depending on the scale of reference.

Therefore, discriminant function analyses are applicable to granitic data and appear more useful and more revealing than traditional methods of comparisons.

The answer to the question :Is the Moroccan model that correlates the Meguma terrane to north-western Africa correct?, is possibly. Although no clear evidence was found to confirm the Moroccan Model for the origin of the Meguma zone, it can not be ruled out as a potential source area.

6.2 Recommendations for Future Work

Throughout the thesis different questions remaining to be resolved were outlined the following points are recommended for possible future consideration:

1- Increase the number of variates and cases (analyses) in the database to allow more elaborate comparisons of the granite populations. In particular the inclusion of REE and other immobile elements could possibly improve the modelling. Systematic isotopic analyses (e.g. Pb, Nd, Sr and O) are also needed to improve the comparison between the granites.

2- Include other potential areas for correlation, as well as those areas which are not correlated to allow better comparisons (e.g. Columbia).

3- Study the geochemical data using other parametric statistical methods. In addition the applicability of non-parametric multivariate statistics to the geochemical data needs to be assessed.

4- Many of the plutons considered in this study were not sampled systematically, therefore more comprehensive detailed work is needed to better constrain each geochemical population.

5- Study the effects of analytical error and interlaboratory differences on the results.

6- Investigate the origin of the Meguma terrane using other geological evidence.

APPENDIX A

MODAL ANALYSIS

Modal analysis were carried out on the Moroccan granites using the following stain and point counting method:

1- Slabs of granite were cut using a diamond rock saw to a thickness of 0.5-1.5 cm. All alteration surfaces were removed at this stage using the saw.

2- A clean surface of each slab was then immersed in hydrofluoric acid for approximately 1 minute.

3- The slabs were then rinsed in a bath of tap water for about 15-30 seconds.

4- Slabs were then immersed in a saturated solution of sodium cobaltinitrite for approximately 45 seconds - 2 minutes (the length of this stage is highly dependent on the state of the solution i.e. the number of samples previously stained, and the desired intensity of the stain).

5- Slabs were then rinsed (2-3 seconds) in a bath of tap water to remove excess solution.

6- Slabs were then dried using acetone.

7- The stained slabs were point counted using a binocular microscope. The slabs are mounted on a piece of modelling clay to insure that the surface being point counted is horizontal for easy focussing. A grid in placed onto this surface and point counting is done at 1 mm intervals (>1000 points, generally 1500-2000 points are counted). K-feldspar (dark yellow) plagioclase (light yellow to light gray), quartz (glassy gray), biotite and muscovite were counted.

8- A model 100 computer was used during the point counting. A basic program was written (not included in this thesis) to compute the modal % and determine rock classifications using Steckeisens (1976) terminology.

APPENDIX B

B.1 Petrographic Description of Analytical Samples

B.1.1 Definition of Terms Used in the Petrographic Descriptions

B.1.1.1 Quality of Outcrop (Modified M^{c}kenzie, 1974)

Excellent: Large outcrop with abundant fresh surfaces.
Good: Large to intermediate-sized outcrop with some fresh surfaces.
Fair: Intermediate to small outcrop with few fresh surfaces.
Poor: Weathered outcrop with rare fresh surfaces.

B.1.1.2 Degree of Alteration (Modified M^{c}Kenzie, 1974)

Fresh: Minor alteration of plagioclase, alkali feldspar and biotite showing minor amounts of secondary sericite, kaolinite and chlorite.
Moderate: Moderate feldspar kaolinization and muscovite alteration.
Extensive: Alteration of feldspar intense, biotite extensively or completely muscovitized and/or chloritized.

B.1.1.3 Grain Size (Same as M^{c}kenzie, 1974)

Coarse > 5 mm
Medium 1-5 mm
Fine < 1 mm

B.1.2 Petrographic Description of Chemically Analyzed Samples

B.1.2.1 Oulad Ouaslam Batholith

JBL-1B

Quality of outcrop: Poor
Degree of alteration: Moderate - Extensive

Fine-grained aplite (classified as a monzogranite) with quartz, seritised and muscovitised plagioclase, K-feldspar (microcline twinning), minor sligthly chloritized biotite and moderatly kinked muscovite.

JBL-2A

Quality of outcrop: Fair
Degree of alteration: Moderate

Fine- to medium- grained granodiorite with quartz, plagioclase, K-feldspar (found in clots and generally includes plagioclase) (feldspar are saussuritized), biotite is slightly chloritized and includes opaques and zircons. Abundant secondary muscovite.

JBL-3

Quality of outcrop: Good
Degree of alteration: Moderate

Fine- to medium- grained monzogranite with quartz, plagioclase, K-feldspar (found in clots and generally includes plagioclase), minor biotite (slightly chloritized) and muscovite with opaques, zircons and apatite. Minor clots of biotite, muscovite, quartz, opaques and apatite can be found throughout the rock.

JBL-6

Quality of outcrop: Good
Degree of alteration: Moderate

Fine- to medium-grained granodiorite with quartz, plagioclase, K-feldspar (in individual small crystals and as phenocrysts) feldspars are seritised, biotite and muscovite. Small veins (microscopic) of opaques are observed cross-cutting the rock. The rock is slightly foliated (defined by biotite, muscovite and feldspars).

JBL-8

Quality of outcrop: Good
Degree of alteration: Fresh

Mediun- to coarse grained granodiorite with quartz, seritised plagioclase and K-feldspar (as phenocrysts), abundant biotite (includes opaques, zircon and apatite), and minor muscovite and zircon. Clots of biotite, muscovite, quartz minor garnet and sillimanite are present in hand specimen (not included in the analysis).

JBL-10

Quality of outcrop: Excellent
Degree of alteration: Fresh

Medium- to coarse grained granodiorite with quartz, seritised plagioclase and K-feldspar (as phenocrysts), chloritized biotite (include opaques, zircon and apatite), and muscovite. Accessory phases are apatite, cordierite and sillimanite.

<u>JBL-12</u>

Quality of outcrop: Excellent
Degree of alteration: Fresh to moderate

Fine-grained granodiorite with quartz, seritised plagioclase and K-feldspar, minor chloritized biotite and, muscovite. Accessory phases are apatite, cordierite and garnet. Inclusions of biotite muscovite and cordierite in hand specimen (not included in the analysis).

<u>JBL-13</u>

Quality of outcrop: Good
Degree of alteration: Moderate

Medium-grained monzogranite with quartz, seritised plagioclase and K-feldspar (as clots), chloritized biotite (inclusions of apatite and opaques), and muscovite. Accessory phase is apatite. Biotite and muscovite are generally found as clots (shadow inclusions?).

<u>JBL-21</u>

Quality of outcrop: Excellent
Degree of alteration: Moderate to fresh

Medium- to coarse grained granodiorite with quartz, plagioclase, K-feldspar (phenocrysts), abundant biotite (slightky chloritized) and, muscovite. Accessory phases are garnet, cordierite, sillimanite? and apatite.

<u>JBL-23</u>

Quality of outcrop: Good
Degree of alteration: Fresh

Medium-grained granodiorite with quartz, plagioclase, K-feldspar, biotite and muscovite. Accessory phases are sillimanite?, cordierite, and apatite. Shadow enclaves? are present in hand specimen (not included in the analysis).

<u>JBL-24</u>

Quality of outcrop: Excellent
Degree of alteration: Moderate to fresh

Fine-grained granodiorite with quartz, plagioclase, K-feldspar, chloritized biotite and muscovite. Minor clots of biotite, muscovite, quartz, opaques can be found throughout the rock.

JBL-26

Quality of outcrop: Good
Degree of alteration: Moderate

Medium- to coarse- grained monzogranite with quartz, plagioclase, K-feldspar (as phenocrysts and interstially), chloritized biotite and, muscovite.

JUB-4

Quality of outcrop: Good to excellent
Degree of alteration: Fresh to moderate

Medium-grained monzogranite with quartz, plagioclase, K-feldspar (as phenocrysts) chloritized biotite and, muscovite. Accessory phases are cordierite, sillimanite?, and garnet. Shadow enclaves? are observed in hand specimen (not included in analysis).

JUB-6

Quality of outcrop: Good to excellent
Degree of alteration: Fresh to moderate

Fine-grained granodiorite with quartz plagioclase (as phenocrysts) and K-feldspar, slightly chloritized biotite and minor muscovite. Accessory phases are opaques.

JUB-9

Quality of outcrop: Good
Degree of alteration: Moderate to fresh

Fine- to medium-grained granodiorite with quartz plagioclase, K-feldspar (as phenocrysts and interstially), chloritized biotite (opaque inclusions) and, muscovite. In hand specimen shadow enclaves? are evident with cordierite and garnet (not included in analysis).

JUB-18

Quality of outcrop: Good to excellent
Degree of alteration: Moderate to fresh

Fine-grained monzogranite with quartz plagioclase, K-feldspar (as phenocrysts and interstially), chloritized biotite (inclusion of apatite and zircon), and muscovite. Accessory phase is apatite. In hand specimen cordierite and biotite clots are visible and may represent shadow enclaves?.

JUB-19

Quality of outcrop: Excellent
Degree of alteration: Fresh

Fine- to medium grained granodiorite with quartz, plagioclase, K-feldspar (as clusters), slightly chloritized biotite (inclusions of apatite and zircon), and muscovite. Accessory phase is andalusite (in thin section). Clots of biotite, muscovite and plagioclase may represent shadow enclaves.

JUB-21

Quality of outcrop: Good to excellent
Degree of alteration: Moderate to fresh

Fine-grained monzogranite with quartz, seritised plagioclase and K-feldspar, biotite (inclusions of apatite, opaques, and zircon), and muscovite. Accessory phase is cordierite (shadow enclave?).

JUB-24

Quality of outcrop: Excellent
Degree of alteration: Moderate to fresh

Fine-grained monzogranite with quartz, seritised plagioclase and K-feldspar. Minor phases are chloritized biotite (inclusions opaques and zircon), muscovite, cordierite and opaques.

B.1.2.2 Tabouchennt-Bamega Pluton

BRR-7C

Quality of outcrop: Excellent
Degree of alteration: Fresh

Fine- to medium-grained monzogranite with quartz, seritised plagioclase and K-feldspar. The plagioclase is observed mantling the K-feldspar to form phenocrysts. Minor phases are chloritized biotite (inclusions opaques and zircon) and muscovite.

BRR-11A

Quality of outcrop: Good
Degree of alteration: Fresh

Coarse-grained phophyritic monzogranite with quartz, seritised plagioclase (phenocrysts) and K-feldspar (large phenocrysts), and minor chloritized biotite (inclusions opaques and zircon) and muscovite.

BRR-12A

Quality of outcrop: Good to excellent
Degree of alteration: moderate

Medium-grained monzogranite with quartz, seritised plagioclase and K-feldspar, biotite and muscovite. A slight foliation is defined by the biotite and K-feldspar.

BRR-14

Quality of outcrop: Excellent
Degree of alteration: Fresh

Medium- to coarse- grained quartz, plagioclase and K-feldspar (interstially and as phenocrysts), biotite (inclusions of opaques, apatite and zircon), and minor muscovite (possibly cordierite in thin section?).

BRR-16A

Quality of outcrop: Excellent
Degree of alteration: Fresh

Medium- to coarse- grained monzogranite with quartz, seritised plagioclase and K-felsdpar (interstially and as phenocrysts), chloritized biotite (inclusions of opaques, apatite and zircon), and muscovite.

BRR-18

Quality of outcrop: Excellent to good
Degree of alteration: Fresh

Medium-grained porphyritic monzogranite with quartz, seritised plagioclase and K-feldspar, biotite and muscovite. The plagioclase mantles the K-feldspar to form phenocrysts.

BRR-22A

Quality of outcrop: Good
Degree of alteration: Fresh

Fine-grained equigranular monzogranite with quartz, seritised plagioclase and K-feldspar, biotite and muscovite (no thin section for this sample).

B.1.2.3 Sebt De Brikiine Batholith

SDB-1

Quality of outcrop: Excellent
Degree of alteration: Fresh

Fine-grained aplite (classified as a monzogranite) with quartz, plagioclase and, K-feldspar. The feldspars are pink and appear hematized. Accessory phases are opaques and rare biotite.

SDB-2A

Quality of outcrop: Good
Degree of alteration: Moderate

Medium- to coarse grained monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

SDB-3

Quality of outcrop: Excellent
Degree of alteration: Fresh to moderate

Fine-grained equigranular monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

SDB-4

Quality of outcrop: Good to excellent
Degree of alteration: Moderate

Fine-grained aplite (classified as a monzogranite) with quartz, plagioclase and, K-feldspar. The feldspars are pink and appear hematized. Accessory phases are opaques and rare biotite.

SDB-6

Quality of outcrop: Good to excellent
Degree of alteration: Moderate

Fine-grained equigranular monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

SDB-7

Quality of outcrop: Excellent
Degree of alteration: Moderate

Medium- to coarse-grained equigranular syenogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

SDB-8

Quality of outcrop: Excellent
Degree of alteration: Fresh to moderate

Fine-grained aplite (classified as a monzogranite) with quartz, plagioclase and, K-feldspar. The feldspars are pink and appear hematized. Accessory phases are opaques and rare biotite.

SDB-9

Quality of outcrop: Excellent to good
Degree of alteration: moderate

Fine-to medium-grained equigranular monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

SDB-10

Quality of outcrop: Good
Degree of alteration: Moderate

Medium- to coarse-grained monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. There are three different types of phenocrysts, plagioclase, K-feldspar and plagioclase mantling the K-feldspar. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

SDB-11

Quality of outcrop: Excellent to good
Degree of alteration: Fresh to moderate

Medium-grained monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

SDB-12

Quality of outcrop: Good
Degree of alteration: Moderate

Fine-grained aplite (classified as a monzogranite) with quartz, plagioclase and, K-feldspar. The feldspars are pink and appear hematized. Accessory phases are opaques and rare biotite.

SDB-13

Quality of outcrop: Good to excellent
Degree of alteration: Moderate to fresh

Fine-grained monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. There are three different types of phenocrysts, plagioclase, K-feldspar(less abundant) and plagioclase mantling the K-feldspar. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

SDB-14

Quality of outcrop: Good to excellent
Degree of alteration: Moderate to fresh

Fine-grained equigranular monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product (no thin section for this sample).

B.1.2.4 Ajar El Bark Stock

QR-2

Quality of outcrop: Excellent
Degree of alteration: Fresh to moderate

Medium-grained equigranular monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

QR-4

Quality of outcrop: Excellent
Degree of alteration: Fresh to moderate

Medium-grained equigranular monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink phenocrysts and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

QR-6

Quality of outcrop: Excellent
Degree of alteration: Fresh to moderate

Fine-grained equigranular monzogranite with quartz, seritised plagioclase and K-feldspar. The feldspar are pink phenocrysts and appear hematized. Minor phases are biotite and opaques. Minor muscovite as an alteration product.

APPENDIX C

C.1 Sample Selection, Analytical Methods and, Precision and Acuracy

C.1.1 Sample Selection

Approximately one hundred and twenty samples were collected from the Jebilet and Rehamna Massif granites. All except those from the Ras El Abiod pluton were slabed, stained and, point counted to determine the modal quartz, K-feldspar and Plagioclase content. Thin sections of these samples were also made and examined. Based on this data, 70 representative samples were chosen for whole rock chemical analysis. Geographic location was also considered in sample selection, with the objective of obtaining a good regional coverage of the granites.

C.1.2 Sample Pulverization

Weathered or contaminated surfaces were removed using a rock saw. The specimens were then broken down into cubes of approximately 2x2x2 cm using a cut rock. Any remaining weathered or contaminated surfaces were removed at this stage. Fresh fragments were deposited into a Dayton Tow Crusher (model 4K 731) which has ceramic plates. The samples were then split using a Soiltest splitter. Finally, a representative sample of approximately 200 to 300 grams was pulverized in a Siebtechnik tungsten carbide ring mill (model TS 250) until the sample was less than 100 mesh. A ceramic ring mill was used for the REE samples to avoid the tungsten contamination. All equipment were carefuly cleaned after each preparation to avoid contamination.

C.1.3 Major and Trace Element Analysis

Whole rock trace element analysis were done at St. Mary's University by K.Cameron and major element analysis were done at McGill University by S.T. Ahmedali. Both laboratories use the same equipment and methods of sample preparation and analysis. Samples were analysed on a Philips DW 1400 sequential x-ray fluorescence spectrometer using a Phanode x-ray tube. Fused glass disks were used to determine the major elements while pressed powder pellets were used for trace elements. Loss on ignition (LOI) was determined by heating the sample for 1.5 hours at 1050 C in an electric furnace. Analytical precision as determined on replicate analyses is generally better than 5% for the major oxides and between 5-10% for trace elements.

C.1.4 Rare Earth Element Analysis (NAA)

Ten samples were analysed for Ce, Nd, Sm, Eu, Gd, Tb, Yb and Lu. Unfortunately Lanthanum was not determined. The analyses were done at Waterloo University using neutron activation. Approximately 0.1-0.2 grams of rock powder were weighed and sealed in clean plastic containers. Two international standards and one repeat sample are considered to determine the precision and accuracy.

Table C.1. Duplicate major element analysis from the Sebt de Brikiine batholith (McGill University).

	SDB-4	SDB-4D	Percent Deviation
SiO_2	76.96	77.55	0.77
TiO_2	0.07	0.07	0.00
Al_2O_3	12.63	12.58	0.40
Fe_2O_{3t}	0.83	0.84	1.20
MnO	0.01	0.01	0.00
MgO	0.01	0.01	0.00
CaO	0.33	0.03	0.00
Na_2O	3.93	3.83	2.54
K_2O	4.69	4.59	2.13
P_2O_5	0.02	0.02	0.00

Table C.2. Duplicate major element analysis from the Oulad Ouaslam batholith (McGill University).

	JUB-6	JUB-6D	Percent Deviation
SiO_2	68.57	68.66	0.13
TiO_2	0.48	0.48	0.00
Al_2O_3	15.75	15.70	0.32
Fe_2O_{3t}	3.21	3.19	0.62
MnO	0.05	0.05	0.00
MgO	1.01	1.04	2.97
CaO	2.02	2.04	0.99
Na_2O	3.86	3.84	0.52
K_2O	3.65	3.63	0.55
P_2O_5	0.13	0.13	0.00

Table C.3. Duplicate major element analysis from the Tabouchennt-Bamega pluton (McGill University).

	BRR-16	BRR-16D	Percent Deviation
SiO_2	70.93	71.66	1.03
TiO_2	0.43	0.44	2.33
Al_2O_3	14.28	14.34	0.42
Fe_2O_{3t}	3.46	3.29	4.91
MnO	0.06	0.05	16.67
MgO	0.79	0.76	3.80
CaO	1.57	1.46	7.01
Na_2O	2.59	2.59	0.00
K_2O	4.88	4.97	1.84
P_2O_5	0.12	0.13	8.33

Table C.4. Duplicate major element analysis from the Tabouchennt-Bamega pluton (McGill University).

	BRR-14	BRR-14D	Percent Deviation
SiO_2	71.09	70.64	0.63
TiO_2	0.45	0.48	6.67
Al_2O_3	14.59	14.69	0.69
Fe_2O_{3t}	3.28	3.51	7.01
MnO	0.05	0.04	20.00
MgO	0.69	0.69	0.00
CaO	1.57	1.53	2.55
Na_2O	2.65	2.72	2.64
K_2O	4.90	5.06	3.27
P_2O_5	0.12	0.13	8.33

Table C.5. Major element precision using the international standard G-2, granite (McGill University).

	Abbey, 1983	Obtained McGill	Percent Deviation
SiO_2	69.22	69.05	0.25
TiO_2	0.48	0.48	0.00
Al_2O_3	15.40	15.48	0.52
Fe_2O_{3t}	2.69	2.70	0.37
MnO	0.03	0.03	0.00
MgO	0.75	0.72	4.00
CaO	1.96	2.00	2.04
Na_2O	4.06	4.08	0.49
K_2O	4.46	4.45	0.22
P_2O_5	0.13	0.13	0.00

Table C.6. Major element precision using the international standard NIM-1, granite (McGill University).

	Sarm, 1979	Obtained McGill	Percent Deviation
SiO_2	75.70	72.23	0.62
TiO_2	0.09	0.09	0.00
Al_2O_3	12.08	12.20	0.99
Fe_2O_{3t}	2.02	1.99	1.49
MnO	0.02	0.02	0.00
MgO	0.06	0.01	83.33
CaO	0.78	1.42	83.05
Na_2O	3.36	3.25	3.27
K_2O	4.99	4.97	0.40
P_2O_5	0.01	0.01	0.00

Table C.7. Duplicate trace element analysis from the Ajar el Bark stock (St-Mary's University).

	QR-4	QR-4D	Percent Deviation
Ba	84	88	4.76
Rb	291	291	0.00
Sr	28	29	3.57
Y	62	65	4.84
Zr	80	79	1.25
Nb	17	19	11.76
Th	34	30	11.76
Pb	28	20	28.57
Ga	18	20	11.11
Zn	15	19	26.67
Cu	1	2	100.00
Ni	36	38	5.56
Ti_2O	0.05	0.05	0.00
V	4	1	75.00
Cr	3	10	233.33

Table C.8. Duplicate trace element analysis from the Sebt de Brikiine batholith (St-Mary's University).

	SDB-4	SDB-4D	Percent Deviation
Ba	15	24	60.00
Rb	368	367	0.27
Sr	9	9	0.00
Y	53	51	3.77
Zr	134	132	1.49
Nb	67	68	1.49
Th	55	52	5.45
Pb	23	22	4.35
Ga	22	21	4.55
Zn	11	13	18.18
Cu	1	1	0.00
Ni	42	42	0.00
Ti_2O	0.06	0.06	0.00
V	0	3	100.00
Cr	9	5	44.44

Table C.9. Duplicate trace element analysis from the Oulad Ouaslam batholith (St-Mary's University).

	JUB-6	JUB-6D	Percent Deviation
Ba	778	770	1.03
Rb	130	128	1.54
Sr	631	631	0.00
Y	24	25	4.17
Zr	160	163	1.88
Nb	10	10	0.00
Th	2	7	250.00
Pb	20	21	5.00
Ga	20	19	5.00
Zn	50	44	12.00
Cu	12	8	33.33
Ni	17	19	11.76
Ti_2O	0.53	0.52	1.89
V	54	61	12.96
Cr	38	38	0.00

Table C.10. Duplicate trace element analysis from the Tabouchennt-Bamega pluton (St-Mary's University).

	BRR-16	BRR-16D	Percent Deviation
Ba	360	344	4.44
Rb	259	258	0.39
Sr	74	76	2.70
Y	43	44	2.33
Zr	168	164	2.38
Nb	11	11	0.00
Th	22	21	4.55
Pb	21	22	4.76
Ga	19	20	5.26
Zn	38	43	13.16
Cu	7	6	14.29
Ni	28	31	10.71
Ti_2O	0.45	0.45	0.00
V	50	47	6.00
Cr	27	23	14.81

Table C.11. Duplicate trace element analysis of the internal standard HFL-1 (St-Mary's University).

	HFL-1A	HFL-1B	Percent Deviation
Ba	892	903	1.23
Rb	217	215	0.92
Sr	207	206	0.48
Y	36	35	2.78
Zr	194	193	0.52
Nb	21	21	0.00
Th	19	20	5.26
Pb	28	26	7.14
Ga	26	29	11.54
Zn	109	105	3.67
Cu	31	31	0.00
Ni	36	44	4.35
Ti_2O	1.07	1.07	0.00
V	126	121	3.97
Cr	105	111	5.71

Table C.12. Duplicate Rare Earth element analysis from the Tabouchennt-Bamega pluton. (Waterloo University).

	BRR-7C	BRR-7CD	Percent Deviation
Ce	97.19	97.19	0.00
Nd	45.62	44.68	2.06
Sm	10.40	10.72	3.08
Eu	0.95	0.90	5.26
Tb	1.35	1.46	8.15
Yb	5.60	5.57	0.54
Lu	0.73	0.74	1.37

Table C.13. Rare Earth element precision using the international standard G-2, granite (Waterloo University).

	Abbey, 1983	Obtained Waterloo	Percent Deviation
Ce	400	500.28	27.00
Nd	190	260.17	36.90
Sm	26.8	32.96	22.90
Eu	2.4	2.72	13.30
Tb	1.36	0.81	40.40
Yb	1.7	2.19	28.80
Lu	-	-	-

Table C.14. Rare Earth element precision using the international standard NIM-1, granite (Waterloo University).

	Sarm, 1979	Obtained Waterloo	Percent Deviation
Ce	195	204.26	4.70
Nd	72	80.40	11.20
Sm	15.8	15.07	4.60
Eu	0.35	0.34	2.80
Tb	14	16.16	15.40
Yb	3	4.60	53.30
Lu	14.2	14.46	1.80

APPENDIX D

D.1 Source References for the Geochemical Database

D.1.1 Nova Scotia

Sample Prefix	Author(s)
NAL	De Alburquerque, 1977
NBC	Bernadette, 1982
NBM	Rodgers, 1985
NBP	Smith, 1979; Rogers, 1985
NCH	Charest, 1976
NDW	Dwyer, 1975
NEH	Weagle, 1983
NEK	Richardson, in prep.
NFE	Farley, 1979
NIW	Wolfson, 1983
NKA	Alizay, 1981
NLB	Rodgers, 1985
NLH	Ham, in prep.
NLI	Cameron, 1985
NLR	O'Reilly, 1988
NMD	McDonald, 1981; McDonald and Clarke, 1985
NMK	McKenzie, 1974; McKenzie and Clarke, 1975
NMO	Weagle, 1983
NOE	O'Reilly, 1976
NPL	Allan, 1983
NPM	De Alburquerque, 1977; Douma, 1988
NPS	Smith, 1977
NSH	Rodgers, 1985
NSI	Rodgers, 1985
NSL	O'Reilly, 1988
NTS	Smith et al., 1987
NWG	Rodgers, 1985

D.1.2 Morocco

Sample Prefix	Author(s)
MAG	Mahmood, 1980
MAL	Mahmood and Bennani, 1984
MAM	Mahmood, 1980
MBC	Analysis from D.B. Clarke (Unpubl.)
MBR	This study
MHU	Huvelin, 1974
MJB	This study
MJU	This study
MME	Mahmood and Bennani, 1984
MMG	Boushaba, 1984
MMN	Boushaba, 1984
MMQ	Boushaba, 1984
MMT	Boushaba, 1984
MMZ	Boushaba, 1984
MOU	Mahmood and Bennani, 1984
MQR	This study
MSD	This study
MTI	Vogel and Walker, 1975; Vogel et al., 1976; Scott and Vogel, 1980
MZA	Guiliani, 1982

D.1.3 Iberia

Iberian analyses courtesy of J.L. Barrera.

D.1.4 Australia

Sample Prefix	Author(s)
ABB	White et al., 1977
AKB	Hine et al., 1978
AKO	White et al., 1977
AMO	Chappell, 1978
AMU	Flood and Shaw, 1977
ARP	Price and Taylor, 1977
ASB*	Clemens, 1981
AST	Philips et al., 1981
AWB	Shaw et al., 1982
TBT*	Higgins et al., 1985

* Data excluded from final analysis

D.2 Pluton Abbreviations

D.2.1 Nova Scotia

BMOU - Bald Mountain
BPAS - Barrington Passage
BRID - Bull Ridge
BREN - Brenton
CSMB - South Mountain
DLAK - South Mountain (Davis Lake)
EHEA - Eastern Head
ELAK - Ellison Lake
HALI - South Mountain (Halifax)
HCOV - Halfway Cove
KINS - Kinsac
LBAY - Lyons Bay
LISC - Liscomb
LRIV - Larry's River

MLAK - Mulgrave

MUSQ - Musquodoboit

MPOI - Moose point

NROS - South Mountain (New Ross)

PMOU - Port Mouton

QUEE - Queensport

SHEL - Shelburne

SHER - Sherbrooke

SISL - Seal Island

SLAK - Sangster Lake

TURN - South Mountain (Turner)

WALK - South Mountain (Walker)

WEDG - Wedgeport

WEST - Western Granite

D.2.2 Morocco

MENT - Ment

ZAER - Zaer

OULM - Oulmes

SDBR - Debt de Brikiine

AEBA - Ajar El Bark

TBAM - Tabouchennt-Bamega

OUOU - Oulad Ouaslam

TICH - Tichka

D.2.3 Other

UNKN - Not specified

D.3 Lithologies

ALAS - Alaskite

APLI - Aplite

DRMI - Dyke rock minor intrusives

GRAD - Granodiorite

GRAN - Granite

LMON - Leuco monzogranite

LTON - Leuco tonalite

MONG - Monzogranite

PORP - Porphyry

SYEN - Syenogranite

TONA - Tonalite

NOVA SCOTIA

	NAL1 BPAS TONA	NAL10 SHEL MONG	NAL11 SHEL APLI	NAL2 BPAS TONA	NAL3 BPAS TONA	NAL6 PMOU GRAD	NAL7 PMOU GRAD	NAL8 PMOU MONG	NAL9 PMOU MONG
SiO_2	66.39	72.74	73.42	64.13	63.93	72.10	73.25	70.02	70.86
TiO_2	.72	.19	.04	.74	.79	.23	.22	.41	.41
Al_2O_3	16.48	15.35	16.62	17.75	17.78	16.15	15.62	16.44	16.55
Fe_2O_3	.70	.23	.36	.75	.59	.31	.24	.19	.33
FeO	3.12	.97	1.11	3.12	3.33	1.37	1.13	1.80	1.63
MnO	.06	.04	.28	.06	.07	.03	.03	.04	.04
MgO	1.56	.28	.10	1.96	2.11	.33	.42	.71	.62
CaO	3.66	.82	.52	4.07	3.93	1.36	1.33	1.68	1.74
Na_2O	3.64	3.65	4.31	3.94	3.74	3.82	3.79	3.66	3.73
K_2O	2.18	3.97	3.08	2.19	2.33	3.54	3.52	4.17	3.80
P_2O_5	.18	.07	.06	.25	.24	.06	.07	.13	.11
H_2O+	1.18	.77	.40	.78	1.15	.83	.73	.67	.57
H_2O-	.11	.04	.02	.08	.10	.08	.04	.05	.10
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.98	99.12	100.32	99.82	100.09	100.21	100.39	99.97	100.49
Fe_2O_3t	4.16	1.31	1.59	4.21	4.29	1.83	1.49	2.19	2.14
A/CNK	1.1	1.3	1.5	1.1	1.1	1.3	1.3	1.2	1.2
DI	69.9	88.8	89.5	66.9	66.6	86.2	87.3	83.5	83.9
Ba	415.	-	-	445.	442.	478.	365.	836.	573.
Rb	80.	-	-	85.	86.	158.	171.	158.	154.
Sr	304.	-	-	345.	352.	99.	87.	198.	154.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1. Geochemical database

NOVA SCOTIA

	NMK100A CSMB DRMI	NMK102 CSMB MONG	NMK114 CSMB MONG	NMK116A CSMB DRMI	NMK119 CSMB MONG	NMK121 CSMB MONG	NMK123 CSMB DRMI	NMK124 CSMB GRAD	NMK127 CSMB GRAD
SiO_2	75.00	73.70	74.50	74.10	74.30	73.50	74.00	68.80	72.20
TiO_2	.09	.26	.12	.09	.22	.18	.18	.68	.42
Al_2O_3	14.20	13.42	13.40	14.07	13.08	13.87	13.20	14.52	14.26
Fe_2O_3	.58	.17	.16	.23	.05	.22	.17	.45	.26
FeO	.62	1.69	1.51	.82	1.77	1.55	1.09	3.88	2.52
MnO	.03	.04	.05	.03	.05	.03	.03	.10	.09
MgO	.08	.28	.12	.10	.24	.24	.08	1.18	.75
CaO	.53	.58	.45	.44	.66	.60	.43	2.21	1.44
Na_2O	4.57	3.32	3.46	3.84	3.60	3.54	4.00	3.18	3.31
K_2O	3.60	4.91	4.59	4.37	4.34	4.72	4.31	3.46	4.04
P_2O_5	.28	.07	.14	.14	.07	.15	.21	.10	.16
H_2O+	1.01	.82	.58	.79	.77	.69	.68	.91	.88
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	.14	.13	.28	.33	.10	.18	.26	.05	.06
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.73	99.39	99.36	99.35	99.25	99.47	98.64	99.52	100.39
Fe_2O_3t	1.27	2.05	1.84	1.14	2.01	1.94	1.38	4.76	3.06
A/CNK	1.2	1.1	1.2	1.2	1.1	1.2	1.1	1.1	1.2
DI	94.8	90.8	91.8	92.8	90.7	91.0	93.0	76.2	84.6
Ba	8.	230.	66.	16.	200.	164.	28.	668.	429.
Rb	402.	330.	532.	660.	299.	441.	620.	143.	174.
Sr	-	-	-	-	-	-	-	156.	112.
Y	-	-	-	-	-	-	-	-	-
Zr	-	91.	51.	-	76.	64.	20.	210.	168.
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	10.90	2.05	11.00	-	4.43	-	8.33
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	33.0	72.0	64.0	43.0	56.0	64.0	64.0	71.0	60.0
Cu	-	-	-	-	-	-	-	-	-
Ni	9.0	8.0	8.0	9.0	10.0	9.0	9.0	16.0	12.0
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	42.	43.	45.	37.	47.	47.	38.	50.	42.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	22.0	19.0	30.0	40.0	15.0	20.0	25.0	7.0	18.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NBC001 BRID MONG	NBC002 BRID MONG	NBC003 BRID MONG	NBC004 BRID MONG	NBC005 BRID MONG	NBC006 BRID MONG	NBC007 BRID MONG	NBC008 BRID MONG	NBC009 BRID MONG
SiO_2	73.20	73.20	72.50	74.40	73.20	72.60	73.50	73.50	72.40
TiO_2	.13	.22	.22	.22	.15	.14	.13	.15	.17
Al_2O_3	15.00	15.10	15.90	14.40	14.50	15.50	15.20	15.00	15.30
Fe_2O_3	.19	.16	.32	.11	.05	.09	.19	.15	.34
FeO	.77	.90	.82	1.02	.90	.90	.72	.73	.56
MnO	.02	.03	.03	.02	.03	.02	.03	.03	.02
MgO	.30	.36	.39	.40	.35	.38	.27	.29	.25
CaO	.39	.50	.44	.46	.47	.49	.56	.58	.39
Na_2O	3.90	3.46	3.58	3.20	3.82	3.88	3.96	3.78	3.71
K_2O	4.83	4.93	5.20	5.36	5.26	5.98	4.52	4.72	4.76
P_2O_5	.40	.44	.39	.24	.31	.34	.32	.31	.24
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.90	1.00	1.00	1.00	.70	.60	.70	.70	.90
TOTAL	100.03	100.30	100.79	100.83	99.74	100.92	100.10	99.94	99.04
Fe_2O_3t	1.04	1.16	1.23	1.24	1.05	1.09	.99	.96	.96
A/CNK	1.2	1.3	1.3	1.2	1.1	1.1	1.2	1.2	1.3
DI	92.6	91.5	91.8	92.5	93.0	94.0	92.2	92.1	91.4
Ba	300.	340.	350.	395.	425.	520.	285.	380.	350.
Rb	255.	180.	280.	240.	230.	200.	195.	190.	360.
Sr	54.	60.	55.	115.	160.	170.	135.	135.	49.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	4.00	4.00	3.00	8.00	5.00	9.00	2.00	2.00	2.00
Pb	20.	14.	15.	22.	17.	41.	27.	29.	21.
Ga	-	-	-	-	-	-	-	-	-
Zn	58.0	63.0	55.0	53.0	57.0	21.0	27.0	41.0	49.0
Cu	9.0	11.0	9.0	8.0	10.0	10.0	10.0	9.0	9.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	197.0	230.0	203.0	100.0	90.0	60.0	120.0	214.0	135.0
Be	10.0	6.8	7.5	4.4	6.4	3.7	6.3	5.1	4.6
B	11.0	14.0	6.0	5.0	4.0	4.0	50.0	6.0	6.0
F	340.	400.	380.	230.	210.	250.	270.	280.	340.
Cl	-	-	-	-	-	-	-	-	-
U	3.80	3.60	3.90	4.00	3.20	3.50	3.50	2.50	7.20
W	-	-	-	-	-	-	-	-	-
Sn	9.4	8.7	8.9	6.2	6.0	4.7	7.1	7.1	7.0
Mo	1.00	1.30	.80	.80	.80	.60	.70	.70	.90
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NBC010 BRID MONG	NBC011 BRID MONG	NBC012 BRID MONG	NBM106 BMOU MONG	NBM148 BMOU MONG	NBM193 BMOU MONG	NBMA52 BMOU MONG	NBP233 BPAS TONA	NBP243 BPAS TONA
SiO_2	73.40	72.20	72.80	73.34	74.11	73.23	71.60	69.82	61.95
TiO_2	.23	.22	.18	.17	.17	.22	.20	.68	.94
Al_2O_3	15.00	16.30	15.10	14.84	14.21	14.54	15.30	15.02	17.83
Fe_2O_3	.30	.04	.15	1.30	1.45	1.59	1.40	3.49	5.95
FeO	.90	.90	.86	–	–	–	–	–	–
MnO	.02	.03	.01	.03	.04	.04	.02	.05	.12
MgO	.50	.39	.33	.18	.22	.29	.67	.97	2.18
CaO	.58	.46	.60	.63	.65	.67	.68	2.63	4.03
Na_2O	3.62	4.06	4.01	3.60	3.50	3.33	3.94	3.64	3.43
K_2O	5.21	5.14	4.86	4.49	4.50	4.49	4.53	2.45	2.58
P_2O_5	.32	.31	.28	.33	.33	.32	.30	.13	.16
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	.80	.90	.80	.99	.84	.86	1.00	.55	–
TOTAL	100.88	100.95	99.98	99.90	100.02	99.58	99.64	99.43	99.17
Fe_2O_3t	1.30	1.04	1.10	1.30	1.45	1.59	1.40	3.49	5.95
A/CNK	1.2	1.3	1.2	1.2	1.2	1.3	1.2	1.1	1.1
DI	92.3	92.3	92.0	91.5	91.9	90.4	89.8	77.8	65.0
Ba	350.	500.	650.	453.	352.	620.	410.	1108.	1022.
Rb	255.	295.	170.	219.	196.	190.	174.	70.	93.
Sr	54.	61.	80.	59.	70.	60.	60.	359.	396.
Y	–	–	–	11.	15.	–	10.	25.	23.
Zr	–	–	–	74.	74.	–	62.	281.	246.
Nb	–	–	–	9.	11.	–	8.	10.	12.
Th	7.00	4.00	7.00	6.30	6.30	–	7.70	2.10	2.80
Pb	16.	29.	22.	23.	30.	–	24.	14.	13.
Ga	–	–	–	19.	17.	–	18.	18.	22.
Zn	59.0	62.0	40.0	48.0	39.0	–	44.0	48.0	74.0
Cu	8.0	11.0	11.0	–	–	–	–	–	–
Ni	–	–	–	3.0	1.0	–	3.0	4.0	16.0
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	8.	5.	–	2.	52.	135.
Cr	–	–	–	47.	39.	–	37.	38.	86.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	144.0	130.0	51.0	154.0	134.0	170.0	158.0	46.0	48.0
Be	5.6	14.0	8.5	5.2	5.2	–	7.4	2.8	1.0
B	3.0	4.0	6.0	–	–	–	–	–	–
F	360.	420.	250.	330.	380.	370.	430.	460.	60.
Cl	–	–	–	–	–	–	–	–	–
U	4.60	3.40	3.60	6.10	5.90	–	5.70	2.80	.90
W	–	–	–	–	–	–	–	–	–
Sn	5.9	7.4	5.2	8.0	14.0	–	5.0	7.0	14.0
Mo	.60	.70	1.00	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NBP265 BPAS TONA	NBP302 BPAS TONA	NBP344 BPAS TONA	NBP345 BPAS TONA	NBP348 BPAS TONA	NBP361 BPAS TONA	NBP364 BPAS TONA	NBP386 BPAS TONA	NBP387 BPAS TONA
SiO_2	67.27	65.94	64.28	67.60	63.32	66.01	68.73	67.83	60.91
TiO_2	.73	.76	.74	.66	.48	.86	.78	.64	1.07
Al_2O_3	15.45	16.20	16.92	15.91	18.93	15.57	15.08	15.55	18.08
Fe_2O_3	4.10	4.47	4.96	4.50	3.67	5.46	4.46	4.62	6.74
FeO	-	-	-	-	-	-	-	-	-
MnO	.07	.11	.06	.08	.07	.10	.06	.11	.11
MgO	2.10	2.08	2.39	2.12	1.70	2.30	1.61	2.10	2.43
CaO	3.08	3.59	3.30	3.42	4.13	3.28	2.36	3.05	3.57
Na_2O	3.81	3.98	3.64	4.09	4.81	2.76	3.11	3.05	3.36
K_2O	1.96	2.03	2.20	1.98	2.57	2.48	2.13	1.81	2.74
P_2O_5	.16	.26	.23	.38	.82	.15	.05	.16	.23
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.61	.61	.98	.69	.57	.81	.90	.71	.88
TOTAL	100.34	100.03	99.70	101.43	101.07	99.78	99.27	99.63	100.12
Fe_2O_3t	4.10	4.47	4.96	4.50	3.67	5.46	4.46	4.62	6.74
A/CNK	1.1	1.1	1.2	1.1	1.0	1.2	1.3	1.2	1.2
DI	72.2	70.6	68.5	73.1	72.3	68.4	74.1	70.5	64.9
Ba	355.	401.	563.	-	701.	438.	718.	560.	918.
Rb	79.	74.	124.	-	86.	181.	81.	61.	105.
Sr	341.	278.	80.	-	341.	63.	311.	339.	361.
Y	10.	16.	15.	-	33.	12.	10.	18.	26.
Zr	191.	174.	51.	-	148.	88.	191.	198.	245.
Nb	11.	13.	8.	-	14.	8.	11.	10.	12.
Th	2.50	3.00	2.00	3.20	1.90	2.40	1.60	.40	4.40
Pb	15.	12.	29.	-	17.	24.	18.	18.	22.
Ga	20.	19.	15.	-	20.	21.	18.	18.	23.
Zn	71.0	69.0	37.0	-	55.0	77.0	57.0	57.0	81.0
Cu	-	-	-	-	-	-	-	-	-
Ni	12.0	12.0	3.0	-	11.0	5.0	8.0	11.0	22.0
TiO_2	-	-	-	-	-	-	-	-	-
V	93.	83.	1.	-	54.	9.	74.	83.	136.
Cr	95.	80.	27.	-	44.	37.	79.	66.	92.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	55.0	49.0	61.0	50.0	48.0	78.0	41.0	37.0	52.0
Be	2.7	2.3	.5	3.1	-	1.1	.9	2.6	3.4
B	-	-	-	-	-	-	-	-	-
F	360.	410.	670.	870.	-	520.	490.	490.	640.
Cl	-	-	-	-	-	-	-	-	-
U	1.10	1.90	1.60	1.20	2.00	1.10	1.70	1.20	2.00
W	-	-	-	-	-	-	-	-	-
Sn	5.0	7.0	5.0	-	2.0	13.0	11.0	11.0	14.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

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	NBP391 BPAS TONA	NBP403 BPAS TONA	NBP405 BPAS TONA	NBP415 BPAS TONA	NBP418 BPAS GRAD	NBP531 BPAS TONA	NBP560 BPAS TONA	NBP562 BPAS TONA	NBP594 BPAS TONA
SiO_2	70.03	66.59	65.75	68.95	72.39	63.37	64.42	65.13	66.20
TiO_2	.29	.67	.81	.51	.42	.95	.85	.90	.71
Al_2O_3	16.68	15.83	15.58	15.02	14.14	16.52	16.33	15.73	16.30
Fe_2O_3	1.62	4.51	4.86	3.64	2.54	6.04	5.32	5.61	4.67
FeO	–	–	–	–	–	–	–	–	–
MnO	.04	.08	.08	.08	.07	.12	.10	.14	.08
MgO	.81	2.20	2.20	1.66	1.16	2.08	2.31	2.39	2.41
CaO	2.98	2.98	2.98	3.03	2.38	2.90	3.47	3.27	3.34
Na_2O	5.44	3.63	3.63	4.07	3.56	3.55	3.24	3.19	3.75
K_2O	1.15	2.67	2.67	1.66	1.94	2.76	2.70	2.30	2.32
P_2O_5	.06	.25	.26	.17	.11	.47	.17	.20	.24
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	.49	.69	.99	.84	.87	1.07	.83	.88	.61
TOTAL	99.59	100.10	99.81	99.63	99.58	99.83	99.74	99.74	100.63
Fe_2O_3t	1.62	4.51	4.86	3.64	2.54	6.04	5.32	5.61	4.67
A/CNK	1.1	1.1	1.1	1.1	1.2	1.2	1.1	1.2	1.1
DI	79.4	72.8	72.0	74.7	79.3	70.5	68.2	68.4	70.9
Ba	156.	270.	545.	255.	348.	690.	843.	735.	423.
Rb	36.	92.	105.	79.	74.	110.	95.	85.	111.
Sr	720.	250.	260.	282.	228.	306.	390.	339.	274.
Y	7.	15.	17.	9.	7.	35.	17.	16.	22.
Zr	125.	166.	165.	164.	107.	234.	215.	189.	169.
Nb	3.	13.	17.	15.	9.	16.	10.	13.	12.
Th	2.70	4.60	4.30	1.60	4.70	5.30	1.90	4.30	3.50
Pb	11.	18.	16.	12.	17.	23.	17.	11.	13.
Ga	21.	19.	20.	19.	15.	21.	19.	18.	23.
Zn	44.0	75.0	80.0	48.0	52.0	84.0	65.0	76.0	78.0
Cu	–	–	–	–	–	–	–	–	–
Ni	7.0	10.0	16.0	18.0	10.0	23.0	21.0	17.0	15.0
TiO_2	–	–	–	–	–	–	–	–	–
V	33.	90.	102.	65.	48.	103.	114.	111.	84.
Cr	40.	75.	97.	84.	85.	73.	81.	81.	74.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	42.0	58.0	60.0	40.0	52.0	57.0	34.0	152.0	59.0
Be	2.5	2.6	3.6	3.6	2.6	3.2	2.3	2.2	–
B	–	–	–	–	–	–	–	–	–
F	810.	430.	430.	460.	340.	490.	560.	410.	410.
Cl	–	–	–	–	–	–	–	–	–
U	2.00	3.00	1.00	.80	2.00	1.90	1.20	1.40	2.80
W	–	–	–	–	–	–	–	–	–
Sn	5.0	3.0	4.0	1.0	12.0	10.0	8.0	–	3.0
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NBP608 BPAS TONA	NBP610 BPAS TONA	NBP633 BPAS TONA	NBP642 BPAS TONA	NBP652 BPAS TONA	NBP665 BPAS TONA	NBPA07 BPAS TONA	NBPA08 BPAS TONA	NBPA13 BPAS TONA
SiO_2	65.86	67.08	70.77	67.10	69.74	67.06	66.40	70.13	66.80
TiO_2	.68	.64	.69	.67	.57	.57	.64	.49	.56
Al_2O_3	15.98	15.80	14.19	16.15	14.91	14.91	15.80	14.94	15.90
Fe_2O_3	4.55	4.31	4.60	4.76	3.64	3.64	4.55	3.02	4.28
FeO	-	-	-	-	-	-	-	-	-
MnO	.09	.09	.07	.09	.08	.08	.05	.07	.07
MgO	2.29	2.06	1.64	2.53	1.00	1.00	1.96	1.47	1.77
CaO	3.22	3.23	1.36	3.18	1.96	1.96	3.29	2.45	2.81
Na_2O	3.94	4.07	2.75	3.66	3.34	3.34	4.05	3.90	4.06
K_2O	2.06	1.89	2.57	2.49	3.55	3.55	2.02	2.32	2.70
P_2O_5	.23	.20	.12	.32	.33	.33	.21	.17	.21
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.63	.53	1.05	.66	.98	.98	.31	.83	.85
TOTAL	99.53	99.90	99.81	101.61	100.10	97.42	99.28	99.79	100.01
Fe_2O_3t	4.55	4.31	4.60	4.76	3.64	3.64	4.55	3.02	4.28
A/CNK	1.1	1.1	1.5	1.1	1.2	1.2	1.1	1.1	1.1
DI	70.9	72.4	78.4	72.3	81.2	78.5	71.9	78.3	75.1
Ba	233.	225.	650.	532.	156.	-	380.	-	380.
Rb	101.	91.	85.	105.	36.	-	60.	-	110.
Sr	239.	231.	226.	278.	720.	-	320.	-	290.
Y	22.	19.	25.	31.	7.	-	-	-	-
Zr	157.	156.	217.	178.	125.	-	-	-	-
Nb	15.	14.	14.	13.	3.	-	-	-	-
Th	1.70	3.60	3.40	3.50	2.70	-	-	-	-
Pb	12.	17.	15.	13.	11.	-	-	-	-
Ga	20.	22.	18.	25.	21.	-	-	-	-
Zn	78.0	68.0	65.0	77.0	44.0	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	21.0	15.0	23.0	17.0	7.0	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	74.	65.	73.	86.	33.	-	-	-	-
Cr	73.	69.	84.	76.	40.	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	59.0	63.0	117.0	54.0	42.0	-	54.0	-	71.0
Be	3.3	2.8	2.9	3.4	2.5	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	410.	380.	340.	430.	810.	-	520.	-	500.
Cl	-	-	-	-	-	-	-	-	-
U	2.40	2.20	1.70	2.00	2.00	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	5.0	7.0	8.0	-	5.0	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NBPA19 BPAS TONA	NBPA21 BPAS TONA	NCH10 NROS DRMI	NCH113 NROS DRMI	NCH115 NROS DRMI	NCH117 NROS DRMI	NCH12 NROS DRMI	NCH13 NROS DRMI	NCH140 NROS DRMI
SiO_2	66.10	67.60	72.90	-	74.22	74.75	74.54	-	-
TiO_2	.66	.71	.03	-	.06	.08	.05	-	-
Al_2O_3	16.10	15.50	14.77	-	14.14	13.98	13.92	-	-
Fe_2O_3	4.37	5.21	.22	-	.22	.22	.22	-	-
FeO	-	-	.67	-	.83	.87	.72	-	-
MnO	.09	.07	.03	-	.03	.02	.02	-	-
MgO	2.07	1.49	.08	-	.03	.15	.08	-	-
CaO	3.42	2.41	.70	-	.36	.43	.54	-	-
Na_2O	4.04	3.83	4.39	-	4.27	4.43	4.92	-	-
K_2O	2.29	2.32	4.22	-	4.84	5.18	4.25	-	-
P_2O_5	.22	.16	.38	-	.17	.17	.23	-	-
H_2O+	-	-	.76	-	.89	.74	.76	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.00	.85	-	-	-	-	-	-	-
TOTAL	100.36	100.15	99.15	-	100.06	101.02	100.25	-	-
Fe_2O_3t	4.37	5.21	.96	.00	1.14	1.19	1.02	.00	.00
A/CNK	1.1	1.2	1.1	-	1.1	1.0	1.0	-	-
DI	71.8	75.6	93.0	-	95.5	96.7	96.0	-	-
Ba	320.	540.	32.	9.	64.	72.	15.	17.	20.
Rb	80.	90.	608.	673.	684.	409.	626.	366.	676.
Sr	350.	400.	9.	2.	8.	19.	4.	8.	4.
Y	-	-	-	-	-	-	-	-	-
Zr	200.	360.	51.	43.	53.	41.	43.	46.	31.
Nb	-	-	15.	15.	16.	11.	16.	10.	15.
Th	6.00	12.00	-	-	-	-	-	-	-
Pb	6.	8.	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	77.0	81.0	-	-	-	-	-	-	-
Cu	-	-	5.0	9.0	59.0	4.0	8.0	5.0	6.0
Ni	22.0	21.0	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	59.0	53.0	363.0	450.0	281.0	801.0	289.0	123.0	411.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	400.	450.	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	2.20	2.70	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	3.0	3.0	24.0	39.0	40.0	20.0	32.0	18.0	45.0
Mo	-	-	2.00	1.00	1.00	2.00	1.00	1.00	2.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NCH14A NROS PORP	NCH15 NROS LMON	NCH16 NROS MONG	NCH165 NROS MONG	NCH16A NROS LMON	NCH16B NROS PORP	NCH17 NROS LMON	NCH18 NROS LMON	NCH18A NROS MONG
SiO_2	74.34	-	-	-	-	-	-	-	-
TiO_2	.12	-	-	-	-	-	-	-	-
Al_2O_3	13.54	-	-	-	-	-	-	-	-
Fe_2O_3	.15	-	-	-	-	-	-	-	-
FeO	1.35	-	-	-	-	-	-	-	-
MnO	.03	-	-	-	-	-	-	-	-
MgO	.21	-	-	-	-	-	-	-	-
CaO	.39	-	-	-	-	-	-	-	-
Na_2O	3.52	-	-	-	-	-	-	-	-
K_2O	4.77	-	-	-	-	-	-	-	-
P_2O_5	.13	-	-	-	-	-	-	-	-
H_2O+	.90	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.45	-	-	-	-	-	-	-	-
Fe_2O_3t	1.65	.00	.00	.00	.00	.00	.00	.00	.00
A/CNK	1.2	-	-	-	-	-	-	-	-
DI	92.6	-	-	-	-	-	-	-	-
Ba	69.	12.	115.	257.	26.	338.	68.	-	236.
Rb	358.	590.	484.	407.	511.	289.	720.	847.	293.
Sr	12.	6.	10.	37.	7.	34.	17.	22.	47.
Y	-	-	-	-	-	-	-	-	-
Zr	76.	33.	95.	105.	56.	72.	61.	43.	120.
Nb	9.	15.	14.	13.	12.	12.	16.	16.	14.
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	9.0	6.0	6.0	5.0	43.0	6.0	8.0	12.0	10.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	415.0	370.0	658.0	207.0	450.0	147.0	668.0	535.0	279.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	1.0	-	-	-	-	-	1.0	-	1.0
Sn	23.0	45.0	34.0	31.0	43.0	32.0	40.0	52.0	6.0
Mo	2.00	1.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NCH19 NROS MONG	NCH19A NROS LMON	NCH2 NROS PORP	NCH20 NROS MONG	NCH21 NROS DRMI	NCH22 NROS DRMI	NCH23A NROS DRMI	NCH3 NROS DRMI	NCH3A NROS MONG
SiO_2	75.18	-	76.01	74.21	74.87	74.01	74.00	-	75.93
TiO_2	.21	-	.10	.12	.08	.03	.03	-	.09
Al_2O_3	12.70	-	13.26	13.93	13.52	14.64	13.80	-	13.81
Fe_2O_3	.11	-	.15	.11	.22	.22	.22	-	.11
FeO	1.53	-	1.15	1.14	.86	.77	.55	-	.96
MnO	.03	-	.03	.02	.02	.02	.03	-	.02
MgO	.31	-	.15	.21	.11	.07	.06	-	.11
CaO	.55	-	.45	.40	.59	.49	.74	-	.38
Na_2O	3.31	-	3.27	3.58	4.00	4.70	4.13	-	4.15
K_2O	3.95	-	4.98	5.18	4.24	3.95	4.01	-	4.76
P_2O_5	.14	-	.20	.15	.22	.28	.32	-	.20
H_2O+	.89	-	.83	.72	.67	.82	.92	-	.72
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	98.91	-	100.58	99.77	99.40	100.00	98.81	-	101.24
Fe_2O_3t	1.81	.00	1.43	1.38	1.17	1.07	.83	.00	1.18
A/CNK	1.2	-	1.1	1.1	1.1	1.1	1.1	-	1.1
DI	90.6	-	94.3	93.6	93.5	94.5	93.0	-	96.4
Ba	180.	17.	34.	145.	326.	20.	-	19.	85.
Rb	278.	931.	723.	356.	289.	820.	-	640.	680.
Sr	34.	8.	9.	24.	48.	7.	-	8.	10.
Y	-	-	-	-	-	-	-	-	-
Zr	94.	43.	69.	70.	72.	35.	-	38.	60.
Nb	10.	17.	15.	11.	12.	20.	-	15.	14.
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	7.0	15.0	8.0	10.0	7.0	4.0	-	6.0	4.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	221.0	439.0	325.0	131.0	154.0	493.0	-	353.0	438.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	1.0	1.0	-	-	-	-	-	-
Sn	35.0	43.0	26.0	6.0	31.0	49.0	-	47.0	35.0
Mo	3.00	2.00	4.00	1.00	1.00	2.00	-	2.00	2.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NCH4 NROS MONG	NCH5 NROS PORP	NCH6 NROS PORP	NCH7A NROS DRMI	NCH8 NROS DRMI	NCH9 NROS DRMI	NCH97 NROS DRMI	NCH9A NROS DRMI	NDW21 MLAK MONG
SiO_2	74.43	–	74.89	74.92	73.14	75.00	75.37	–	74.04
TiO_2	.16	–	.09	.08	.03	.02	.07	–	.21
Al_2O_3	13.69	–	13.48	14.07	14.84	14.31	14.32	–	14.52
Fe_2O_3	.11	–	.15	.11	.22	.22	.22	–	.14
FeO	1.45	–	1.03	1.04	.63	.59	.68	–	1.16
MnO	.02	–	.03	.03	.04	.02	.05	–	.04
MgO	.23	–	.19	.12	.06	.05	.03	–	.45
CaO	.58	–	.37	.41	.63	.47	.34	–	.60
Na_2O	3.62	–	3.78	3.88	4.71	4.98	4.24	–	3.53
K_2O	5.08	–	4.95	4.57	4.24	3.63	3.48	–	4.53
P_2O_5	.17	–	.14	.24	.39	.30	.16	–	.33
H_2O+	.94	–	.82	1.07	.72	.73	1.03	–	.66
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	100.48	–	99.92	100.54	99.65	100.32	99.99	–	100.21
Fe_2O_3t	1.72	.00	1.29	1.26	.92	.87	.97	.00	1.43
A/CNK	1.1	–	1.1	1.2	1.1	1.1	1.3	–	1.2
DI	93.3	–	94.5	94.5	94.3	95.8	94.0	–	91.6
Ba	180.	60.	74.	20.	–	11.	–	398.	–
Rb	473.	354.	384.	879.	–	840.	–	444.	–
Sr	28.	17.	14.	10.	–	7.	–	49.	–
Y	–	–	–	–	–	–	–	–	–
Zr	94.	73.	65.	50.	–	37.	–	84.	–
Nb	12.	11.	8.	14.	–	22.	–	11.	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	6.0	15.0	26.0	4.0	–	15.0	–	6.0	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	323.0	299.0	140.0	708.0	–	279.0	–	283.0	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	1.0	1.0	–	–	–	–	–	–	–
Sn	31.0	25.0	36.0	48.0	–	34.0	–	26.0	–
Mo	2.00	–	2.00	2.00	–	1.00	–	2.00	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NDW25 MLAK MONG	NDW27 MLAK MONG	NDW4 MLAK MONG	NEH20 EHEA MONG	NEK1 DLAK MONG	NEK10 DLAK MONG	NEK2 DLAK MONG	NEK46 DLAK MONG	NEK47 DLAK MONG
SiO_2	75.27	73.33	73.51	71.70	76.50	76.60	77.10	75.70	75.90
TiO_2	.07	.21	.20	.15	.15	.15	.14	.20	.11
Al_2O_3	14.42	14.73	14.56	14.80	12.40	12.00	12.40	12.50	12.60
Fe_2O_3	.03	.11	.25	1.60	.45	.42	.25	.50	.38
FeO	.47	1.18	1.05	–	1.10	1.30	1.20	1.40	1.00
MnO	.02	.04	.04	.06	.04	.04	.04	.04	.04
MgO	.13	.43	.42	.70	.24	.40	.20	.29	.15
CaO	.44	.58	.52	1.10	.50	.70	.63	.62	.49
Na_2O	3.91	3.63	3.64	3.90	3.40	3.30	4.10	3.29	3.49
K_2O	3.89	4.61	4.45	4.40	4.89	4.38	3.31	4.54	4.49
P_2O_5	.40	.35	.38	.16	.06	.09	.07	.10	.07
H_2O+	1.49	.63	.72	.74	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	.20	.13	.05	.14	.23
LOI	–	–	–	–	.77	.54	.85	.54	.54
TOTAL	100.54	99.83	99.74	99.31	100.70	100.05	100.34	99.86	99.49
Fe_2O_3t	.55	1.42	1.42	1.60	1.67	1.86	1.58	2.05	1.49
A/CNK	1.3	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1
DI	94.6	91.4	91.7	88.9	93.7	91.8	92.5	91.5	92.8
Ba	–	–	–	610.	201.	157.	–	220.	170.
Rb	–	–	–	134.	527.	397.	180.	415.	530.
Sr	–	–	–	180.	31.	24.	107.	50.	18.
Y	–	–	–	–	44.	48.	41.	40.	10.
Zr	–	–	–	–	89.	99.	80.	110.	70.
Nb	–	–	–	–	15.	20.	20.	20.	10.
Th	–	–	–	4.00	13.00	15.00	18.00	30.00	24.00
Pb	–	–	–	29.	17.	24.	22.	21.	6.
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	32.0	33.0	34.0	36.0	27.0	17.0
Cu	–	–	–	11.0	11.0	2.0	6.0	4.0	7.0
Ni	–	–	–	–	7.0	5.0	6.0	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	8.	9.	7.	–	–
Cr	–	–	–	–	27.	25.	19.	220.	140.
Hf	–	–	–	–	3.1	3.2	–	–	–
Cs	–	–	–	–	14.0	11.0	5.0	13.0	16.0
Sc	–	–	–	–	4.0	4.0	–	–	–
Ta	–	–	–	–	1.0	.7	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	95.0	98.0	79.0	40.0	113.0	138.0
Be	–	–	–	4.3	10.0	11.0	37.0	–	–
B	–	–	–	4.0	25.0	25.0	25.0	–	10.3
F	–	–	–	400.	2000.	1300.	530.	1400.	2300.
Cl	–	–	–	–	175.	50.	50.	–	–
U	–	–	–	6.40	20.00	26.00	17.00	11.00	15.00
W	–	–	–	–	19.0	12.0	10.0	10.0	10.0
Sn	–	–	–	5.0	15.0	7.0	13.0	12.0	21.0
Mo	–	–	–	.90	2.00	4.00	3.00	1.00	1.00
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NEK53 DLAK MONG	NEK56 DLAK MONG	NEK57 DLAK MONG	NEK9 DLAK MONG	NFE1 WALK MONG	NFE11 TURN MONG	NFE2 TURN MONG	NIW002 WEDG MONG	NIW003 WEDG MONG
SiO_2	74.40	76.21	76.49	75.70	75.83	–	74.70	76.70	75.40
TiO_2	.20	.11	.12	.29	.06	–	.12	.12	.20
Al_2O_3	12.70	12.89	12.73	12.50	13.82	–	14.02	12.30	12.40
Fe_2O_3	.26	1.59	1.77	.65	.13	–	.29	.54	.95
FeO	1.70	–	–	1.40	.79	–	1.42	.80	1.00
MnO	.04	.04	.03	.03	.02	–	.05	.02	.04
MgO	.24	.27	.36	.30	.09	–	.25	.09	.36
CaO	.74	.38	.32	.46	.59	–	.57	.67	.93
Na_2O	3.41	2.98	3.03	3.20	3.68	–	3.31	3.49	3.73
K_2O	4.71	5.13	4.87	4.87	4.30	–	4.27	4.98	5.07
P_2O_5	.09	.10	.06	.08	.36	–	.26	.03	.06
H_2O+	–	–	–	–	.84	–	1.23	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	.24	.21	.06	.08	–	–	–	–	–
LOI	.39	–	–	.77	–	–	–	.93	.70
TOTAL	99.12	99.91	99.84	100.33	100.51	–	100.49	100.67	100.84
Fe_2O_3t	2.15	1.59	1.77	2.20	1.01	.00	1.87	1.43	2.06
A/CNK	1.1	1.2	1.2	1.1	1.2	–	1.3	1.0	.9
DI	90.3	93.8	93.6	92.4	94.3	–	91.6	94.4	93.3
Ba	230.	96.	125.	313.	31.	67.	118.	–	–
Rb	455.	544.	495.	360.	616.	359.	357.	300.	330.
Sr	38.	19.	41.	48.	14.	2.	25.	20.	110.
Y	50.	45.	37.	49.	–	–	–	–	–
Zr	120.	79.	83.	155.	37.	56.	87.	150.	160.
Nb	10.	9.	12.	20.	19.	11.	10.	–	–
Th	34.00	–	–	16.00	–	–	–	–	–
Pb	13.	–	–	24.	–	–	–	16.	6.
Ga	–	–	–	–	–	–	–	–	–
Zn	26.0	22.0	38.0	34.0	–	–	–	30.0	39.0
Cu	5.0	–	–	4.0	–	–	–	10.0	12.0
Ni	–	94.0	95.0	7.0	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	4.	–	19.	–	–	–	–	–
Cr	40.	37.	37.	20.	–	–	–	40.	30.
Hf	–	–	–	4.2	–	–	–	–	–
Cs	14.0	–	–	10.0	–	–	–	–	–
Sc	–	–	–	5.0	–	–	–	–	–
Ta	–	–	–	.7	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	131.0	–	–	58.0	–	–	–	37.0	53.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	25.0	–	–	–	25.0	25.0
F	2400.	2050.	590.	820.	–	–	–	1300.	960.
Cl	–	–	–	50.	–	–	–	–	–
U	13.00	–	–	4.00	–	–	–	–	–
W	10.0	–	–	7.0	–	–	–	24.0	20.0
Sn	8.0	6.0	16.0	11.0	–	–	–	10.0	30.0
Mo	1.00	–	–	3.00	–	–	–	5.50	3.00
La	–	–	–	–	8.	6.	10.	–	–
Ce	–	–	–	–	17.	17.	27.	–	–

Figure D.1 (cont.). Geochemical database.

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	NIW004 WEDG MONG	NIW005 WEDG MONG	NIW006 WEDG MONG	NIW008 WEDG MONG	NKA003 SHER MONG	NKA014 SHER MONG	NKA015 SHER MONG	NKA019 SHER MONG	NKA022 SHER MONG
SiO_2	76.70	75.00	74.60	74.80	72.73	73.26	74.66	75.63	73.38
TiO_2	.09	.20	.22	.23	.25	.17	.18	.22	.21
Al_2O_3	12.80	13.40	13.20	12.90	15.17	15.73	14.43	13.76	15.13
Fe_2O_3	.38	.75	.76	.84	.32	.23	.24	.15	.26
FeO	.80	.90	1.30	1.30	1.16	.85	.86	.02	.95
MnO	.03	.03	.03	.03	.04	.03	.03	.30	.02
MgO	.14	.29	.23	.27	.54	.32	.38	.30	.46
CaO	.52	1.21	.93	.90	.95	.52	.77	.40	.73
Na_2O	4.16	4.28	3.60	3.59	3.14	3.41	2.82	3.40	2.98
K_2O	4.51	4.51	4.99	4.69	4.90	4.65	5.06	4.32	4.93
P_2O_5	.03	.07	.09	.07	.26	.24	.21	.10	.22
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.62	.23	.77	1.23	.80	1.05	.72	.96	.82
TOTAL	100.78	100.87	100.72	100.85	100.26	100.46	100.36	99.56	100.09
Fe_2O_3t	1.27	1.75	2.20	2.28	1.61	1.17	1.19	.17	1.31
A/CNK	1.0	1.0	1.0	1.0	1.2	1.4	1.3	1.3	1.3
DI	95.4	92.9	91.8	91.3	88.4	90.5	90.5	92.6	89.3
Ba	-	-	-	-	376.	111.	342.	91.	430.
Rb	320.	220.	360.	300.	237.	243.	235.	236.	230.
Sr	-	60.	70.	80.	102.	48.	86.	34.	96.
Y	-	-	-	-	-	-	-	-	-
Zr	90.	130.	160.	160.	100.	75.	77.	59.	100.
Nb	-	-	-	-	19.	21.	21.	7.	3.
Th	-	-	-	-	9.00	8.00	2.00	17.00	2.00
Pb	10.	10.	16.	4.	30.	29.	33.	53.	39.
Ga	-	-	-	-	-	-	-	-	-
Zn	21.0	25.0	38.0	21.0	53.0	51.0	39.0	41.0	26.0
Cu	-	-	4.0	4.0	-	-	-	2.0	-
Ni	-	-	-	-	-	48.0	-	2.0	26.0
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	5.	-	-	2.	-
Cr	40.	50.	30.	40.	244.	13.	179.	4.	5.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	7.0	-	7.0	6.0
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	49.0	92.0	76.0	57.0	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	25.0	50.0	25.0	-	-	-	-	-
F	310.	500.	1200.	860.	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	12.00	15.00	19.00	-	22.00
W	4.0	4.0	34.0	18.0	-	-	-	-	-
Sn	3.0	7.0	10.0	25.0	-	-	-	-	-
Mo	-	-	10.00	6.50	-	-	-	-	-
La	-	-	-	-	46.	69.	65.	54.	30.
Ce	-	-	-	-	44.	27.	5.	12.	-

Figure D.1 (cont.). Geochemical database.

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	NKA028 SHER MONG	NKA029 SHER MONG	NKA049 SHER MONG	NKA049A SHER MONG	NKA052 SHER MONG	NKA062 SHER MONG	NKA065 SHER MONG	NKA069 SHER MONG	NKA069A SHER MONG
SiO_2	71.00	73.79	75.06	73.83	73.55	72.74	74.56	75.82	74.50
TiO_2	.29	.15	.06	.02	.32	.09	.24	.18	.27
Al_2O_3	15.50	15.50	15.04	14.46	14.45	16.07	14.35	13.33	14.08
Fe_2O_3	.39	.19	.14	.10	.30	.11	.32	.25	.34
FeO	1.30	.70	.51	.38	1.08	.41	1.15	.89	1.24
MnO	.04	.03	.03	.02	.60	.02	.03	.02	.46
MgO	.62	.23	.08	.09	.04	.11	.48	.31	.03
CaO	.66	.54	.41	.38	.60	.60	.76	.50	.40
Na_2O	3.45	3.74	4.12	4.98	3.19	3.61	3.06	2.57	3.44
K_2O	4.52	4.82	3.96	3.67	4.40	5.94	4.47	4.83	4.83
P_2O_5	.27	.25	.31	.32	.12	.20	.23	.18	.10
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.15	.82	.85	.64	1.20	.71	.79	.69	.98
TOTAL	99.19	100.76	100.57	98.89	99.85	100.61	100.44	99.57	100.67
Fe_2O_3t	1.83	.97	.71	.52	1.50	.57	1.60	1.24	1.72
A/CNK	1.3	1.3	1.3	1.1	1.3	1.2	1.3	1.3	1.2
DI	87.2	92.5	93.7	94.2	89.1	93.5	89.6	91.1	91.9
Ba	240.	227.	31.	-	206.	667.	312.	294.	271.
Rb	248.	256.	374.	415.	241.	249.	216.	232.	229.
Sr	67.	61.	24.	30.	60.	105.	90.	75.	64.
Y	-	-	-	-	-	-	-	-	-
Zr	102.	83.	66.	29.	74.	83.	109.	97.	74.
Nb	7.	10.	1.	6.	10.	-	12.	31.	6.
Th	3.00	5.00	9.00	4.00	21.00	2.00	8.00	6.00	25.00
Pb	55.	37.	31.	40.	48.	39.	34.	31.	74.
Ga	-	-	-	-	-	-	-	-	-
Zn	15.0	14.0	17.0	15.0	72.0	16.0	51.0	29.0	49.0
Cu	-	-	-	-	2.0	-	-	-	2.0
Ni	-	38.0	20.0	34.0	3.0	66.0	34.0	21.0	2.0
TiO_2	-	-	-	-	-	-	-	-	-
V	4.	-	-	-	2.	-	-	1.	2.
Cr	404.	9.	-	18.	8.	6.	10.	17.	2.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	5.0	5.0	1.0	5.0	3.0	7.0	6.0	6.0
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	25.00	23.00	26.00	35.00	-	17.00	18.00	16.00	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	22.	57.	68.	37.	29.	60.	62.	55.	27.
Ce	35.	4.	-	15.	43.	-	40.	16.	23.

Figure D.1 (cont.). Geochemical database.

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	NKA083 SHER MONG	NLBA05 LBAY TONA	NLHH01 HCOV MONG	NLHH02 HCOV MONG	NLHH03 HCOV MONG	NLHH04 HCOV MONG	NLHH05 HCOV MONG	NLHH06 HCOV MONG	NLHH07 HCOV MONG
SiO_2	75.55	59.75	72.17	71.40	72.65	72.16	71.56	72.55	71.20
TiO_2	.03	.99	.30	.21	.25	.28	.25	.23	.18
Al_2O_3	14.84	17.50	14.75	14.46	14.72	15.42	15.30	14.78	14.99
Fe_2O_3	.07	6.07	.21	.12	.02	.30	.12	-	-
FeO	.23	-	1.64	1.12	1.38	1.27	1.24	1.54	1.18
MnO	.01	.07	.08	.04	.03	.06	.06	.04	.06
MgO	.04	3.62	.50	.36	.41	.45	.40	.47	.34
CaO	.42	4.91	.50	.54	.55	.48	.52	.54	.48
Na_2O	5.02	3.58	3.18	3.41	3.33	3.39	3.50	3.23	3.61
K_2O	3.77	2.45	4.63	4.77	5.20	4.94	4.92	5.24	4.75
P_2O_5	.03	.35	.37	.31	.32	.30	.35	.33	.34
H_2O+	-	-	1.08	1.00	.85	.89	.88	.59	.79
H_2O-	-	-	.48	.49	.36	.42	.32	.42	.33
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.30	.54	-	-	-	-	-	-	-
TOTAL	100.31	99.83	99.89	98.23	100.07	100.36	99.42	99.96	98.25
Fe_2O_3t	.33	6.07	2.03	1.36	1.55	1.71	1.50	1.71	1.31
A/CNK	1.1	1.0	1.3	1.2	1.2	1.3	1.3	1.2	1.3
DI	95.6	59.4	89.7	90.1	91.5	91.0	90.6	90.8	90.2
Ba	-	400.	215.	274.	384.	322.	310.	378.	276.
Rb	228.	90.	285.	240.	217.	246.	247.	225.	263.
Sr	38.	380.	58.	70.	90.	81.	79.	80.	62.
Y	-	-	14.	11.	11.	11.	11.	10.	11.
Zr	46.	110.	81.	74.	90.	84.	81.	92.	63.
Nb	10.	-	15.	10.	9.	11.	11.	11.	12.
Th	2.00	5.00	10.00	11.00	12.00	11.00	9.00	9.00	8.00
Pb	50.	6.	22.	27.	28.	28.	25.	29.	27.
Ga	-	-	24.	20.	21.	23.	24.	24.	22.
Zn	-	65.0	90.0	60.0	64.0	53.0	55.0	66.0	49.0
Cu	-	-	-	-	-	-	-	-	-
Ni	-	47.0	10.0	4.0	4.0	4.0	3.0	10.0	10.0
TiO_2	-	-	.30	.21	.25	.28	.25	.28	.18
V	-	-	19.	3.	12.	-	13.	13.	12.
Cr	240.	-	23.	12.	10.	19.	15.	19.	9.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	40.0	164.0	108.0	76.0	95.0	108.0	-	-
Be	-	-	7.0	6.5	4.5	4.5	6.5	3.5	4.0
B	-	-	15.0	15.0	25.0	10.0	20.0	20.0	20.0
F	-	560.	690.	530.	510.	540.	570.	450.	530.
Cl	-	-	-	-	-	-	-	-	-
U	11.00	1.90	11.50	7.40	6.20	7.20	5.50	-	-
W	-	-	2.0	5.0	1.0	6.0	4.0	-	-
Sn	-	-	13.0	10.0	1.0	5.0	9.0	9.0	12.0
Mo	-	-	1.00	1.00	1.00	1.00	1.00	2.00	2.00
La	41.	-	-	-	-	-	-	-	-
Ce	20.	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

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	NLHHL18 HCOV MONG	NLHHL34 HCOV MONG	NLHHL37 HCOV MONG	NLHQ00 QUEE MONG	NLHQ01 QUEE MONG	NLHQ02 QUEE MONG	NLHQ03 QUEE MONG	NLHQ04 QUEE MONG	NLHQ05 QUEE MONG
SiO_2	72.37	71.88	74.14	71.05	69.07	69.28	70.10	70.55	71.11
TiO_2	.17	.16	.02	.19	.39	.43	.20	.26	.26
Al_2O_3	14.86	14.66	15.32	15.21	15.57	15.46	14.85	14.76	14.84
Fe_2O_3	.09	–	–	–	.07	.55	.03	–	.14
FeO	1.03	1.12	.74	1.65	2.02	1.84	1.12	1.55	1.28
MnO	.04	.03	.16	.10	.10	.11	.04	.04	.04
MgO	.31	.31	.07	.48	.58	.88	.39	.52	.49
CaO	.52	.50	.39	.93	1.45	1.74	.58	.61	.61
Na_2O	2.73	3.58	3.35	3.44	3.43	3.52	3.54	3.62	3.60
K_2O	5.02	4.73	5.26	4.68	4.14	3.67	5.06	4.85	4.77
P_2O_5	.31	.34	.22	.22	.16	.14	.22	.23	.23
H_2O+	.90	1.07	.79	.70	1.00	1.10	.82	.69	.78
H_2O-	.44	.35	.35	.18	.27	.23	.19	.37	.22
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	98.79	98.73	100.81	98.83	98.25	98.95	97.14	98.05	98.37
Fe_2O_3t	1.23	1.24	.82	1.83	2.31	2.59	1.27	1.72	1.56
A/CNK	1.4	1.2	1.3	1.2	1.2	1.2	1.2	1.2	1.2
DI	89.8	91.1	94.0	87.3	82.9	81.6	88.9	88.6	89.2
Ba	248.	240.	64.	310.	419.	435.	318.	386.	379.
Rb	255.	226.	257.	227.	187.	178.	245.	268.	267.
Sr	65.	66.	34.	94.	146.	168.	79.	82.	77.
Y	9.	9.	8.	13.	17.	18.	10.	9.	8.
Zr	62.	63.	29.	69.	101.	109.	80.	95.	95.
Nb	10.	11.	8.	10.	11.	9.	8.	9.	8.
Th	8.00	10.00	2.00	6.00	13.00	14.00	12.00	19.00	19.00
Pb	23.	65.	32.	34.	31.	26.	26.	26.	25.
Ga	19.	21.	21.	22.	19.	19.	22.	21.	23.
Zn	44.0	195.0	13.0	54.0	58.0	55.0	61.0	68.0	67.0
Cu	–	–	–	–	–	–	–	–	–
Ni	6.0	4.0	6.0	8.0	6.0	6.0	6.0	7.0	3.0
TiO_2	.17	.16	.02	.19	.39	.43	.20	.26	.26
V	5.	5.	–	11.	–	–	–	–	–
Cr	13.	10.	7.	15.	23.	29.	8.	14.	12.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	107.0	36.0	–	–	93.0	–	68.0	96.0	93.0
Be	7.0	6.5	–	–	6.0	3.5	5.0	6.5	5.5
B	15.0	20.0	–	–	20.0	15.0	15.0	10.0	10.0
F	600.	540.	–	–	570.	730.	630.	810.	690.
Cl	–	–	–	–	–	–	–	–	–
U	7.70	24.60	–	–	4.00	–	5.70	2.80	3.60
W	1.0	5.0	–	–	6.0	–	10.0	8.0	3.0
Sn	6.0	6.0	–	–	3.0	6.0	9.0	7.0	13.0
Mo	1.00	1.00	–	–	1.00	2.00	1.00	1.00	1.00
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

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	NLHQ06 QUEE MONG	NLHQ07 QUEE MONG	NLHQ08 QUEE MONG	NLHQ09 QUEE MONG	NLHQ10 QUEE MONG	NLHQ11 QUEE MONG	NLHQ12 QUEE MONG	NLHQ13 QUEE MONG	NLHQ14 QUEE MONG
SiO_2	72.25	69.64	69.63	72.65	71.90	69.00	69.84	70.90	70.93
TiO_2	.26	.33	.39	.24	.22	.41	.35	.27	.31
Al_2O_3	15.12	15.88	15.21	14.99	14.74	15.09	15.29	14.61	15.36
Fe_2O_3	.36	-	-	.03	.15	.64	.16	.05	.28
FeO	1.27	1.95	2.36	1.36	1.05	1.69	1.95	1.44	1.52
MnO	.07	.09	.10	.05	.05	.10	.09	.06	.06
MgO	.57	.74	.90	.52	.42	.86	.81	.59	.69
CaO	1.03	1.79	1.75	.55	.52	1.72	1.67	.81	.86
Na_2O	3.51	3.65	3.48	3.65	3.56	3.40	3.44	3.61	3.55
K_2O	4.44	4.20	3.86	4.83	5.03	4.03	4.23	4.66	4.80
P_2O_5	.18	.12	.13	.25	.23	.14	.13	.20	.26
H_2O+	.85	.80	.83	.94	1.14	.74	.46	.65	.65
H_2O-	.21	.25	.20	.14	.12	.26	.32	.29	.31
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.12	99.44	98.84	100.20	99.13	98.08	98.74	98.14	99.58
Fe_2O_3t	1.77	2.16	2.62	1.54	1.32	2.52	2.32	1.65	1.97
A/CNK	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
DI	88.4	82.8	81.2	91.1	91.2	81.7	82.6	87.9	88.0
Ba	342.	527.	473.	392.	306.	412.	405.	504.	567.
Rb	209.	175.	175.	268.	251.	186.	182.	259.	267.
Sr	113.	184.	167.	75.	73.	160.	162.	93.	94.
Y	14.	14.	16.	10.	11.	19.	15.	11.	12.
Zr	79.	90.	98.	90.	87.	100.	91.	106.	124.
Nb	11.	9.	10.	9.	9.	10.	8.	9.	9.
Th	10.00	12.00	12.00	16.00	13.00	15.00	10.00	21.00	25.00
Pb	30.	32.	30.	24.	25.	30.	27.	25.	26.
Ga	20.	17.	20.	21.	25.	19.	20.	23.	24.
Zn	54.0	46.0	54.0	58.0	74.0	54.0	47.0	72.0	82.0
Cu	-	-	-	-	-	-	-	-	-
Ni	8.0	5.0	7.0	6.0	11.0	6.0	8.0	11.0	12.0
TiO_2	.26	.33	.39	.24	.22	.41	.35	.27	.31
V	13.	-	-	-	10.	-	-	19.	21.
Cr	14.	21.	20.	13.	8.	23.	21.	16.	19.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	114.0	79.0	80.0	102.0	-	-	-	-	-
Be	7.5	5.0	5.5	5.5	3.5	3.0	3.0	2.5	5.0
B	15.0	10.0	20.0	20.0	15.0	15.0	15.0	10.0	15.0
F	660.	540.	540.	790.	550.	670.	470.	1000.	960.
Cl	-	-	-	-	-	-	-	-	-
U	5.80	6.00	5.60	2.90	7.90	6.90	4.20	3.10	3.70
W	3.0	1.0	3.0	5.0	-	-	-	-	-
Sn	9.0	5.0	1.0	9.0	13.0	6.0	6.0	8.0	9.0
Mo	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

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	NLHQ15 QUEE MONG	NLHQ16 QUEE MONG	NLHQ17 QUEE MONG	NLHQ18 QUEE MONG	NLHQ19 QUEE MONG	NLHQ20 QUEE MONG	NLHQ21 QUEE MONG	NLHQ22 QUEE MONG	NLHQL14 QUEE MONG
SiO_2	71.29	70.91	73.67	70.51	72.61	71.63	71.78	70.51	70.40
TiO_2	.24	.28	.24	.25	.26	.24	.26	.38	.31
Al_2O_3	14.74	14.52	14.90	15.00	14.73	15.05	14.90	15.12	14.90
Fe_2O_3	.01	.03	.18	.08	.01	-	.12	.40	.02
FeO	1.38	1.46	1.25	1.34	1.43	1.48	1.38	2.15	1.55
MnO	.05	.06	.04	.05	.04	.05	.05	.12	.05
MgO	.50	.57	.49	.49	.52	.51	.54	.98	.55
CaO	.57	.61	.62	.74	.80	.61	.77	1.53	.77
Na_2O	3.58	3.55	3.64	3.66	3.50	3.62	3.56	3.28	3.54
K_2O	4.62	4.43	4.68	4.70	4.87	4.68	4.78	3.96	4.45
P_2O_5	.24	.20	.24	.24	.23	.23	.24	.15	.20
H_2O+	.78	.68	.94	1.02	.76	.77	.89	1.03	1.16
H_2O-	.35	.26	.25	.28	.25	.11	.21	.17	.20
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	98.35	97.56	101.14	98.36	100.01	98.98	99.48	99.78	98.10
Fe_2O_3t	1.54	1.65	1.57	1.57	1.60	1.64	1.65	2.79	1.74
A/CNK	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
DI	89.1	87.7	91.9	88.6	90.0	89.2	89.4	82.6	87.2
Ba	415.	443.	370.	382.	441.	408.	420.	355.	464.
Rb	282.	245.	268.	275.	256.	269.	266.	188.	265.
Sr	79.	79.	74.	76.	85.	79.	80.	137.	87.
Y	11.	13.	9.	11.	9.	10.	10.	21.	11.
Zr	96.	112.	97.	101.	106.	95.	106.	102.	113.
Nb	10.	10.	10.	10.	9.	8.	10.	11.	9.
Th	20.00	22.00	17.00	18.00	18.00	18.00	19.00	7.00	26.00
Pb	36.	25.	23.	25.	27.	23.	27.	21.	27.
Ga	27.	25.	26.	25.	25.	27.	25.	23.	21.
Zn	64.0	75.0	62.0	62.0	68.0	72.0	69.0	63.0	57.0
Cu	-	-	-	-	-	-	-	-	-
Ni	12.0	8.0	11.0	11.0	10.0	9.0	7.0	11.0	9.0
TiO_2	.24	.28	.24	.25	.26	.24	.26	.38	.31
V	14.	15.	14.	13.	20.	12.	14.	28.	-
Cr	8.	14.	19.	14.	17.	11.	11.	26.	19.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	81.0
Be	-	2.0	4.0	4.0	3.5	4.0	3.0	2.5	5.5
B	-	15.0	150.0	10.0	15.0	20.0	15.0	20.0	20.0
F	-	930.	820.	960.	730.	930.	790.	780.	810.
Cl	-	-	-	-	-	-	-	-	-
U	-	2.80	3.50	5.90	6.50	3.40	3.30	5.50	6.60
W	-	-	-	-	-	-	-	-	8.0
Sn	-	6.0	12.0	12.0	11.0	8.0	11.0	10.0	4.0
Mo	-	2.00	2.00	2.00	2.00	2.00	2.00	3.00	1.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

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	NLHQL32 QUEE MONG	NLHQL38 QUEE MONG	NLI264 LISC GRAD	NLI265 LISC MONG	NLI266 LISC MONG	NLI267 LISC MONG	NLI300 LISC GRAD	NLI305 LISC GRAD	NLI306 LISC GRAD
SiO_2	71.84	69.72	66.18	77.72	72.38	72.98	63.93	64.56	64.28
TiO_2	.33	.27	.82	.08	.17	.17	.82	.82	.49
Al_2O_3	15.01	14.67	16.30	14.56	15.75	15.71	17.70	17.47	15.31
Fe_2O_3	.10	–	4.84	.73	1.08	1.16	5.35	5.39	3.08
FeO	1.62	1.69	–	–	–	–	–	–	–
MnO	.05	.07	.12	.02	.02	.02	.13	.11	.06
MgO	.69	.56	1.55	.21	.36	.34	1.68	1.72	1.15
CaO	.85	1.46	2.04	.31	.43	.42	2.31	2.18	1.46
Na_2O	3.50	3.47	3.51	3.67	3.64	4.14	3.78	3.89	4.07
K_2O	4.51	4.04	3.71	3.57	5.63	4.48	3.55	3.28	3.91
P_2O_5	.20	.07	.32	.34	.37	.34	.29	.31	.26
H_2O+	.71	1.00	–	–	–	–	–	–	–
H_2O-	.37	.14	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	.69	.77	.77	.85	.92	1.23	.85
TOTAL	99.78	97.16	100.08	101.98	100.60	100.61	100.46	100.96	94.92
Fe_2O_3t	1.90	1.88	4.84	.73	1.08	1.16	5.35	5.39	3.08
A/CNK	1.2	1.2	1.2	1.4	1.2	1.3	1.2	1.3	1.1
DI	88.0	83.3	77.4	94.5	93.2	92.7	74.7	75.3	79.1
Ba	506.	293.	963.	82.	346.	468.	869.	819.	563.
Rb	262.	163.	147.	160.	223.	215.	149.	139.	191.
Sr	93.	140.	217.	24.	58.	73.	248.	228.	148.
Y	11.	18.	30.	7.	8.	8.	29.	21.	17.
Zr	119.	79.	232.	17.	68.	60.	259.	263.	155.
Nb	10.	8.	14.	11.	8.	9.	16.	15.	11.
Th	25.00	9.00	11.00	–	7.00	6.00	8.00	13.00	11.00
Pb	25.	30.	37.	19.	24.	31.	25.	18.	27.
Ga	22.	17.	20.	22.	21.	19.	22.	23.	21.
Zn	62.0	42.0	107.0	27.0	50.0	46.0	106.0	79.0	77.0
Cu	–	–	2.0	–	–	–	6.0	4.0	–
Ni	8.0	3.0	10.0	4.0	4.0	5.0	8.0	8.0	8.0
TiO_2	.33	.27	.84	.06	.17	.14	.93	.94	.52
V	–	–	51.	1.	5.	4.	73.	69.	33.
Cr	19.	19.	22.	4.	13.	2.	26.	25.	27.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	91.0	72.0	–	–	–	–	–	–	–
Be	5.0	4.5	–	–	–	–	–	–	–
B	15.0	15.0	–	–	–	–	–	–	–
F	1075.	330.	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	2.90	3.40	–	–	–	–	–	–	–
W	4.0	3.0	–	–	–	–	–	–	–
Sn	1.0	2.0	–	–	–	–	–	–	–
Mo	1.00	1.00	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

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	NLI307 LISC MONG	NLI308 LISC MONG	NLR002 LRIV MONG	NLR003 LRIV MONG	NLR004 LRIV MONG	NLR005 LRIV MONG	NLR006 LRIV MONG	NLR007 LRIV MONG	NLR008 LRIV MONG
SiO_2	73.23	71.93	75.87	72.29	73.69	72.91	72.71	73.67	72.84
TiO_2	.18	.19	.33	.17	.24	.21	.23	.17	.24
Al_2O_3	15.71	15.51	13.49	14.88	14.70	15.30	14.98	14.52	14.70
Fe_2O_3	1.19	1.11	.04	-	.04	-	.01	-	-
FeO	-	-	1.82	1.33	1.52	1.42	1.49	1.47	1.59
MnO	.03	.02	.05	.04	.05	.07	.05	.05	.04
MgO	.41	.33	.64	.39	.53	.55	.58	.51	.47
CaO	.45	.38	.69	.58	.69	.78	.85	.65	.74
Na_2O	4.00	3.89	3.21	3.45	3.44	3.56	3.56	3.45	3.61
K_2O	4.77	4.82	3.26	5.21	4.68	5.04	4.82	4.44	4.38
P_2O_5	.34	.36	.25	.30	.25	.26	.25	.27	.30
H_2O+	-	-	.66	.58	.80	.85	.82	.70	.66
H_2O-	-	-	.12	.14	.14	.12	.14	.11	.08
CO_2	-	-	.16	.07	.19	.16	.15	.16	.19
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.85	.85	-	-	-	-	-	-	-
TOTAL	101.16	99.39	100.59	99.43	100.96	101.23	100.64	100.17	99.84
Fe_2O_3t	1.19	1.11	2.06	1.48	1.73	1.58	1.66	1.63	1.76
A/CNK	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2
DI	93.1	91.8	89.0	91.0	90.9	91.0	90.1	90.4	89.7
Ba	406.	331.	219.	354.	347.	433.	429.	178.	174.
Rb	206.	231.	213.	225.	213.	210.	200.	231.	237.
Sr	65.	50.	79.	82.	101.	117.	121.	63.	61.
Y	9.	6.	-	-	-	-	-	-	-
Zr	71.	71.	100.	81.	79.	80.	85.	71.	71.
Nb	9.	8.	-	-	-	-	-	-	-
Th	6.00	7.00	12.00	8.00	8.00	8.00	9.00	7.00	7.00
Pb	31.	22.	24.	29.	26.	35.	29.	24.	25.
Ga	17.	23.	-	-	-	-	-	-	-
Zn	52.0	35.0	55.0	56.0	50.0	77.0	74.0	56.0	53.0
Cu	-	-	-	-	-	-	-	-	-
Ni	5.0	6.0	-	-	-	-	-	-	-
TiO_2	.17	.17	-	-	-	-	-	-	-
V	9.	2.	-	-	-	-	-	-	-
Cr	8.	6.	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	161.0	116.0	152.0	129.0	141.0	159.0	174.0
Be	-	-	6.0	5.5	5.5	5.5	4.5	5.0	6.0
B	-	-	25.0	20.0	25.0	30.0	25.0	25.0	25.0
F	-	-	470.	350.	420.	370.	370.	890.	470.
Cl	-	-	-	-	-	-	-	-	-
U	-	-	6.60	4.00	5.50	3.40	6.80	4.40	5.10
W	-	-	7.0	3.0	2.0	3.0	2.0	2.0	3.0
Sn	-	-	8.0	2.0	3.0	5.0	4.0	6.0	10.0
Mo	-	-	2.00	1.00	2.00	1.00	1.00	1.00	1.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

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	NLR009 LRIV MONG	NLR010 LRIV MONG	NLR011 LRIV MONG	NLR012 LRIV MONG	NLR013 LRIV MONG	NLR014 LRIV MONG	NMD10 MUSQ MONG	NMD101 MUSQ PORP	NMD102 MUSQ PORP
SiO_2	72.78	71.86	70.53	70.40	74.10	74.27	71.75	73.95	74.14
TiO_2	.40	.40	.34	.34	.22	.09	.32	.09	.09
Al_2O_3	14.85	15.17	15.89	15.63	14.40	14.71	14.61	14.17	14.31
Fe_2O_3	.56	.12	.05	.36	.04	-	-	-	-
FeO	1.70	2.03	1.68	1.56	1.37	.69	1.97	.90	.81
MnO	.05	.05	.04	.04	.04	.06	.09	.04	.03
MgO	.75	.73	.60	.65	.46	.14	.73	.17	.15
CaO	1.08	1.03	.95	1.01	.68	.39	.83	.48	.52
Na_2O	3.47	3.49	3.52	3.58	3.57	4.37	3.60	3.81	3.75
K_2O	3.85	4.43	5.44	5.09	4.45	3.67	4.80	4.12	4.28
P_2O_5	.26	.25	.26	.27	.29	.38	.20	.44	.50
H_2O+	1.02	.81	.73	.57	.42	.38	1.17	1.18	1.28
H_2O-	.07	.15	.12	.13	.07	.18	.15	.05	.08
CO_2	.05	.13	.16	.10	.26	.13	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.89	100.65	100.31	99.73	100.37	99.46	100.22	99.40	99.94
Fe_2O_3t	2.45	2.37	1.91	2.09	1.56	.77	2.19	1.00	.90
A/CNK	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
DI	87.3	87.3	88.7	87.9	91.2	93.3	88.6	92.8	93.4
Ba	327.	401.	591.	540.	169.	12.	384.	48.	379.
Rb	210.	223.	229.	229.	232.	333.	280.	440.	390.
Sr	106.	108.	123.	124.	59.	13.	160.	20.	20.
Y	-	-	-	-	-	-	-	-	-
Zr	122.	115.	97.	108.	70.	29.	120.	40.	30.
Nb	-	-	-	-	-	-	-	-	-
Th	14.00	16.00	12.00	12.00	7.00	2.00	9.50	1.30	10.90
Pb	27.	24.	30.	27.	23.	18.	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	73.0	69.0	58.0	65.0	49.0	28.0	42.2	29.8	26.7
Cu	-	-	-	-	-	-	4.2	3.6	19.9
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	3.8	2.0	3.6
Cs	-	-	-	-	-	-	13.2	24.6	17.4
Sc	-	-	-	-	-	-	5.4	4.8	5.1
Ta	-	-	-	-	-	-	5.1	6.4	4.6
Co	-	-	-	-	-	-	-	-	-
Li	130.0	125.0	113.0	122.0	173.0	104.0	141.2	231.6	131.1
Be	205.0	3.0	4.5	2.5	3.5	10.5	-	-	-
B	25.0	20.0	25.0	25.0	25.0	20.0	-	-	-
F	570.	540.	440.	500.	820.	660.	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	8.50	8.30	8.10	6.80	4.50	14.00	1.90	14.80	4.90
W	1.0	1.0	4.0	1.0	2.0	3.0	-	-	-
Sn	5.0	5.0	1.0	3.0	11.0	19.0	-	-	-
Mo	1.00	1.00	1.00	1.00	1.00	1.00	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NMD103 MUSQ MONG	NMD104 MUSQ DRMI	NMD108 MUSQ DRMI	NMD109 MUSQ MONG	NMD22 MUSQ MONG	NMD44 MUSQ MONG	NMD82 MUSQ DRMI	NMD96 MUSQ MONG	NMD97 MUSQ MONG
SiO_2	71.44	73.43	72.56	74.23	70.77	72.57	74.83	72.26	71.43
TiO_2	.38	.06	.04	.13	.28	.27	.07	.22	.36
Al_2O_3	14.76	14.63	15.21	14.44	14.62	14.34	14.19	14.77	14.52
Fe_2O_3	-	-	-	-	-	-	-	-	-
FeO	2.07	.58	.51	1.00	1.81	1.69	.70	1.40	2.12
MnO	.07	.03	.17	.05	.05	.04	.06	.05	.08
MgO	.15	.10	.08	.35	.61	.54	.06	.52	.78
CaO	1.22	.38	.28	.66	.86	.88	.30	.62	.92
Na_2O	3.45	4.11	3.82	3.74	3.51	3.54	4.58	3.75	3.64
K_2O	4.58	4.15	4.80	4.92	4.65	4.32	3.18	4.62	4.31
P_2O_5	.07	.39	.40	.30	.30	.27	.24	.30	.30
H_2O+	.68	1.35	.90	.84	1.52	1.13	.97	.91	.92
H_2O-	.11	.05	.04	.14	.09	.07	.03	.07	.17
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	98.98	99.26	98.81	100.80	99.07	99.66	99.21	99.49	99.55
Fe_2O_3t	2.30	.64	.57	1.11	2.01	1.88	.78	1.55	2.35
A/CNK	1.2	1.2	1.3	1.1	1.2	1.2	1.2	1.2	1.2
DI	86.7	93.6	92.9	93.4	87.9	88.8	93.8	90.4	87.1
Ba	59.	-	46.	161.	365.	275.	-	252.	278.
Rb	300.	560.	510.	300.	310.	250.	440.	300.	320.
Sr	120.	10.	10.	60.	80.	70.	10.	60.	130.
Y	-	-	-	-	-	-	-	-	-
Zr	130.	30.	20.	50.	90.	80.	40.	70.	100.
Nb	-	-	-	-	-	-	-	-	-
Th	1.30	1.20	1.00	2.50	7.30	8.10	1.30	5.00	7.10
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	52.8	32.3	16.3	37.4	70.6	49.5	25.5	55.8	72.1
Cu	7.0	17.4	11.0	4.3	50.4	5.6	12.2	8.5	16.6
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	1.4	1.8	2.5	1.8	2.7	3.0	2.1	2.1	3.1
Cs	35.3	44.2	24.2	22.1	37.5	19.0	15.0	20.2	34.3
Sc	4.6	3.7	1.7	3.1	4.7	4.2	3.9	4.1	5.7
Ta	7.5	8.0	9.7	6.3	6.2	5.0	8.0	3.8	4.9
Co	-	-	-	-	-	-	-	-	-
Li	178.1	166.4	74.6	149.7	257.9	159.5	50.6	191.7	197.6
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	12.80	19.90	13.10	6.10	9.70	3.80	16.90	2.70	4.00
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NMK100A CSMB DRMI	NMK102 CSMB MONG	NMK114 CSMB MONG	NMK116A CSMB DRMI	NMK119 CSMB MONG	NMK121 CSMB MONG	NMK123 CSMB DRMI	NMK124 CSMB GRAD	NMK127 CSMB GRAD
SiO_2	75.00	73.70	74.50	74.10	74.30	73.50	74.00	68.80	72.20
TiO_2	.09	.26	.12	.09	.22	.18	.18	.68	.42
Al_2O_3	14.20	13.42	13.40	14.07	13.08	13.87	13.20	14.52	14.26
Fe_2O_3	.58	.17	.16	.23	.05	.22	.17	.45	.26
FeO	.62	1.69	1.51	.82	1.77	1.55	1.09	3.88	2.52
MnO	.03	.04	.05	.03	.05	.03	.03	.10	.09
MgO	.08	.28	.12	.10	.24	.24	.08	1.18	.75
CaO	.53	.58	.45	.44	.66	.60	.43	2.21	1.44
Na_2O	4.57	3.32	3.46	3.84	3.60	3.54	4.00	3.18	3.31
K_2O	3.60	4.91	4.59	4.37	4.34	4.72	4.31	3.46	4.04
P_2O_5	.28	.07	.14	.14	.07	.15	.21	.10	.16
H_2O+	1.01	.82	.58	.79	.77	.69	.68	.91	.88
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	.14	.13	.28	.33	.10	.18	.26	.05	.06
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.73	99.39	99.36	99.35	99.25	99.47	98.64	99.52	100.39
Fe_2O_3t	1.27	2.05	1.84	1.14	2.01	1.94	1.38	4.76	3.06
A/CNK	1.2	1.1	1.2	1.2	1.1	1.2	1.1	1.1	1.2
DI	94.8	90.8	91.8	92.8	90.7	91.0	93.0	76.2	84.6
Ba	8.	230.	66.	16.	200.	164.	28.	668.	429.
Rb	402.	330.	532.	660.	299.	441.	620.	143.	174.
Sr	-	-	-	-	-	-	-	156.	112.
Y	-	-	-	-	-	-	-	-	-
Zr	-	91.	51.	-	76.	64.	20.	210.	168.
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	10.90	2.05	11.00	-	4.43	-	8.33
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	33.0	72.0	64.0	43.0	56.0	64.0	64.0	71.0	60.0
Cu	-	-	-	-	-	-	-	-	-
Ni	9.0	8.0	8.0	9.0	10.0	9.0	9.0	16.0	12.0
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	42.	43.	45.	37.	47.	47.	38.	50.	42.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	22.0	19.0	30.0	40.0	15.0	20.0	25.0	7.0	18.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NMK137 CSMB GRAD	NMK156 CSMB DRMI	NMK160 CSMB DRMI	NMK161 CSMB MONG	NMK166 CSMB MONG	NMK172 CSMB GRAD	NMK176 CSMB MONG	NMK182 CSMB DRMI	NMK189 CSMB MONG
SiO_2	68.20	76.00	73.30	72.40	74.30	70.90	72.00	76.30	75.20
TiO_2	.68	.05	.22	.29	.14	.44	.32	.06	.17
Al_2O_3	14.52	13.05	13.53	14.10	13.58	14.08	13.86	13.87	13.71
Fe_2O_3	.45	.06	.19	.18	.12	.29	.08	.09	.08
FeO	3.88	.93	1.66	1.87	1.22	2.48	2.16	.75	1.40
MnO	.10	.04	.06	.05	.06	.10	.06	.04	.04
MgO	1.18	.08	.23	.50	.18	1.03	.54	.11	.27
CaO	2.21	.34	.63	.71	.52	1.84	.78	.45	.51
Na_2O	3.18	3.76	3.19	3.23	3.29	3.08	3.36	3.62	3.32
K_2O	3.46	4.62	4.69	4.83	4.90	3.73	4.43	4.45	4.76
P_2O_5	.10	.17	.16	.10	.06	.02	.31	.05	.16
H_2O+	.94	.70	.72	.74	.65	.93	1.05	.71	.67
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	.07	.05	.15	.16	.06	.05	.08	.07	.09
LOI	-	-	-	-	-	-	-	-	-
TOTAL	98.97	99.85	98.73	99.16	99.08	98.97	99.03	100.57	100.38
Fe_2O_3t	4.76	1.09	2.03	2.26	1.47	3.04	2.48	.92	1.63
A/CNK	1.1	1.1	1.2	1.2	1.2	1.1	1.2	1.2	1.2
DI	75.7	95.1	89.7	88.4	91.7	80.4	87.9	94.2	92.4
Ba	738.	12.	141.	341.	124.	618.	312.	44.	193.
Rb	132.	590.	410.	324.	295.	136.	264.	294.	362.
Sr	174.	-	-	2.	-	154.	22.	-	-
Y	-	-	-	-	-	-	-	-	-
Zr	260.	-	78.	118.	40.	120.	125.	-	44.
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	12.00	19.60	-	9.85	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	68.0	37.0	69.0	62.0	38.0	53.0	60.0	34.0	52.0
Cu	-	-	-	-	-	-	-	-	-
Ni	20.0	9.0	9.0	11.0	8.0	14.0	12.0	8.0	8.0
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	59.	36.	38.	40.	35.	52.	41.	34.	28.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	8.0	30.0	18.0	15.0	10.0	15.0	18.0	20.0	20.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NMK192 CSMB GRAD	NMK197 CSMB DRMI	NMK198 CSMB DRMI	NMK39 CSMB GRAD	NMK43B CSMB DRMI	NMK50 CSMB MONG	NMK52 CSMB DRMI	NMK53 CSMB GRAD	NMK54E CSMB GRAD
SiO_2	69.60	72.40	74.00	70.30	73.60	73.20	75.10	67.40	66.80
TiO_2	.61	.06	.30	.61	.17	.29	.24	.72	.81
Al_2O_3	14.14	14.25	13.50	13.63	14.00	13.93	13.45	14.65	14.41
Fe_2O_3	.43	.22	.22	.50	.27	.20	.51	.33	.87
FeO	3.78	1.01	1.86	3.47	.98	1.80	1.27	4.20	4.71
MnO	.10	.03	.07	.09	.04	.04	.04	.10	.13
MgO	.99	.10	.50	.89	.27	.49	.36	1.24	1.41
CaO	1.82	.48	.91	1.72	.54	.80	.49	2.28	2.28
Na_2O	3.13	3.25	3.07	3.14	3.44	3.24	3.10	3.29	3.32
K_2O	4.08	4.37	4.58	3.85	5.02	5.12	5.28	3.90	3.57
P_2O_5	.14	.36	.05	.05	.14	.04	.05	.14	.10
H_2O+	.76	.79	.71	1.08	.82	.96	.90	.84	.98
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	.06	.63	.04	.06	.04	.06	.04	.06	.08
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.64	97.95	99.81	99.39	99.33	100.17	100.83	99.15	99.47
Fe_2O_3t	4.63	1.34	2.28	4.35	1.36	2.20	1.92	4.99	6.10
A/CNK	1.1	1.3	1.2	1.1	1.2	1.1	1.2	1.1	1.1
DI	79.4	89.9	88.4	80.3	92.1	89.7	93.0	75.6	73.9
Ba	616.	24.	339.	619.	301.	418.	402.	856.	760.
Rb	144.	816.	202.	156.	268.	272.	253.	130.	123.
Sr	111.	-	46.	118.	26.	47.	35.	176.	144.
Y	-	-	-	-	-	-	-	-	-
Zr	198.	-	94.	196.	55.	118.	100.	253.	267.
Nb	-	-	-	-	-	-	-	-	-
Th	11.30	3.26	-	-	6.24	15.10	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	68.0	80.0	49.0	72.0	44.0	62.0	47.0	74.0	82.0
Cu	-	-	-	-	-	-	-	-	-
Ni	16.0	10.0	11.0	16.0	6.0	12.0	8.0	18.0	22.0
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	56.	46.	50.	54.	32.	42.	44.	56.	58.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	16.0	50.0	12.0	10.0	15.0	10.0	10.0	8.0	15.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NMK60 CSMB GRAD	NMK72 CSMB GRAD	NMK82 CSMB MONG	NMK86 CSMB GRAD	NMO11 MPOI MONG	NMO15 MPOI GRAD	NMO16 MPOI GRAD	NMO17 MPOI GRAD	NMO18 MPOI LMON
SiO_2	70.40	68.60	71.10	70.00	72.50	64.10	69.20	67.90	73.20
TiO_2	.54	.61	.42	.55	.16	.73	.47	.37	.16
Al_2O_3	14.42	14.66	14.50	14.71	14.50	15.40	14.80	15.10	14.50
Fe_2O_3	.47	.23	.29	.59	1.00	4.50	2.70	3.10	1.00
FeO	2.62	3.78	2.13	3.45	–	–	–	–	–
MnO	.09	.10	.06	.10	.04	.07	.06	.06	.03
MgO	.74	.98	.63	.85	.30	3.00	1.30	2.00	.30
CaO	1.72	1.93	1.10	1.78	.39	3.30	2.40	2.50	.41
Na_2O	3.47	3.34	3.30	3.72	3.70	3.20	3.40	3.20	2.60
K_2O	4.16	4.10	4.90	4.13	5.10	3.80	4.20	4.40	6.40
P_2O_5	.12	.08	.08	.08	.39	.32	.37	.36	.29
H_2O+	.56	.89	.66	.94	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	.07	.07	.08	.08	–	–	–	–	–
LOI	–	–	–	–	.99	.79	.60	.70	.91
TOTAL	99.38	99.37	99.25	100.98	99.07	99.21	99.50	99.69	99.80
Fe_2O_3t	3.38	4.43	2.65	4.42	1.00	4.50	2.70	3.10	1.00
A/CNK	1.1	1.1	1.1	1.1	1.2	1.0	1.0	1.0	1.2
DI	82.6	78.6	86.1	82.0	92.5	69.8	80.9	78.2	92.9
Ba	632.	732.	491.	672.	590.	980.	1000.	1200.	900.
Rb	162.	148.	221.	172.	120.	174.	159.	166.	192.
Sr	114.	146.	40.	117.	100.	300.	210.	250.	110.
Y	–	–	–	–	–	–	–	–	–
Zr	175.	204.	125.	218.	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	12.00	–	13.20	3.00	9.00	9.00	7.00	3.00
Pb	–	–	–	–	24.	11.	21.	21.	29.
Ga	–	–	–	–	–	–	–	–	–
Zn	60.0	70.0	70.0	68.0	33.0	72.0	53.0	57.0	16.0
Cu	–	–	–	–	7.0	7.0	7.0	7.0	11.0
Ni	12.0	16.0	14.0	15.0	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	42.	52.	44.	51.	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	38.0	100.0	129.0	148.0	55.0
Be	–	–	–	–	8.0	5.0	4.3	6.5	16.0
B	–	–	–	–	12.0	5.0	4.0	3.0	7.0
F	–	–	–	–	320.	540.	510.	510.	310.
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	4.50	6.00	2.60	3.40	6.30
W	–	–	–	–	–	–	–	–	–
Sn	10.0	10.0	7.0	12.0	7.4	6.3	7.8	7.1	10.0
Mo	–	–	–	–	.90	.90	2.20	.80	1.20
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NM06A MPOI GRAD	NM06B MPOI GRAD	NM06M MPOI MONG	NM07 MPOI GRAD	NM09 MPOI MONG	NOE042 BREN MONG	NOE045 BREN MONG	NOE046 BREN MONG	NOE047 BREN MONG
SiO_2	-	70.20	74.50	70.70	73.10	75.72	76.00	76.42	75.56
TiO_2	-	.40	.16	.51	.23	.12	.12	.11	.16
Al_2O_3	-	14.70	14.10	14.90	14.70	12.51	12.37	12.23	12.14
Fe_2O_3	-	2.30	.90	2.60	1.30	.32	.38	.11	.26
FeO	-	-	-	-	-	1.45	1.28	1.32	1.35
MnO	-	.05	.03	.05	.05	.03	.04	.03	.04
MgO	-	1.00	.20	1.50	.40	.10	.07	.07	.13
CaO	-	1.30	.40	2.00	.51	.40	.33	.19	.62
Na_2O	-	3.60	3.60	4.20	3.50	2.69	2.97	3.16	3.20
K_2O	-	4.40	5.10	3.00	5.20	5.59	5.58	5.35	5.21
P_2O_5	-	.45	.31	.36	.38	.20	.10	.03	.04
H_2O+	-	-	-	-	-	.35	.34	.23	.14
H_2O-	-	-	-	-	-	.06	.02	.03	.06
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	1.00	.67	.66	1.10	-	-	-	-
TOTAL	-	99.40	99.97	100.48	100.47	99.54	99.60	99.28	98.91
Fe_2O_3t	.00	2.30	.90	2.60	1.30	1.93	1.80	1.58	1.76
A/CNK	-	1.1	1.2	1.1	1.2	1.1	1.1	1.1	1.0
DI	-	85.9	94.3	82.6	92.6	93.4	94.4	94.7	92.7
Ba	820.	790.	630.	-	650.	-	-	-	-
Rb	148.	150.	127.	-	157.	217.	234.	243.	195.
Sr	190.	190.	108.	-	130.	40.	15.	7.	46.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	79.	90.	93.	145.
Nb	-	-	-	-	-	23.	26.	27.	26.
Th	10.00	7.00	2.00	-	3.00	-	-	-	-
Pb	28.	22.	22.	-	24.	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	45.0	47.0	9.0	-	34.0	-	-	-	-
Cu	8.0	6.0	7.0	-	6.0	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	79.0	78.0	19.0	-	48.0	-	-	-	-
Be	8.5	14.0	8.0	-	20.0	-	-	-	-
B	10.0	8.0	7.0	-	8.0	-	-	-	-
F	340.	320.	200.	-	320.	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	3.40	3.60	3.50	-	3.20	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	7.3	7.8	5.6	-	7.7	-	-	-	-
Mo	1.10	1.30	1.70	-	.80	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NOE050 BREN MONG	NOE059 BREN MONG	NOE061 BREN MONG	NPL014 ELAK GRAD	NPL015 ELAK GRAD	NPL016 ELAK GRAD	NPL017 ELAK GRAD	NPL018 ELAK GRAD	NPL019 ELAK GRAD
SiO_2	71.68	74.76	75.72	68.00	66.00	68.00	67.50	67.00	67.50
TiO_2	.30	.20	.21	.60	.60	.61	.60	.60	.60
Al_2O_3	13.68	12.71	12.55	14.98	14.93	14.92	14.97	15.00	14.89
Fe_2O_3	1.51	.33	.73	4.72	4.72	4.76	4.73	4.72	4.70
FeO	2.15	1.85	1.56	-	-	-	-	-	-
MnO	.08	.06	.06	.10	.10	.09	.10	.09	.07
MgO	.27	.17	.13	1.35	1.33	1.30	1.42	1.28	1.18
CaO	1.05	.57	.84	1.67	1.83	2.05	1.67	1.98	1.33
Na_2O	2.53	2.88	1.52	2.86	2.88	2.88	2.98	2.86	2.74
K_2O	5.41	5.44	5.44	4.38	4.56	4.11	3.89	4.23	4.30
P_2O_5	.21	.15	.17	.19	.10	.19	.20	.20	.19
H_2O+	.52	.61	.53	-	-	-	-	-	-
H_2O-	.08	.03	.13	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	2.05	2.80	.75	1.69	1.10	1.50
TOTAL	99.47	99.76	99.59	100.90	99.85	99.66	99.75	99.06	99.00
Fe_2O_3t	3.90	2.38	2.46	4.72	4.72	4.76	4.73	4.72	4.70
A/CNK	1.2	1.1	1.3	1.2	1.2	1.2	1.2	1.2	1.3
DI	87.0	91.9	89.2	79.6	77.5	78.4	78.4	77.8	79.6
Ba	-	-	-	850.	750.	660.	760.	720.	926.
Rb	209.	173.	180.	154.	167.	152.	139.	172.	174.
Sr	129.	56.	86.	240.	190.	180.	245.	170.	165.
Y	-	-	-	-	-	-	-	-	-
Zr	293.	180.	191.	-	-	-	-	-	-
Nb	29.	28.	26.	-	-	-	-	-	-
Th	-	-	-	16.00	14.00	17.00	17.00	14.00	14.00
Pb	-	-	-	10.	4.	10.	12.	14.	6.
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	59.0	75.0	76.0	36.0	66.0	44.0
Cu	-	-	-	13.0	11.0	12.0	10.0	12.0	15.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	77.0	62.0	82.0	86.0	71.0	78.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	37.0	20.0	51.0	42.0	39.0	58.0
F	-	-	-	410.	540.	640.	600.	490.	510.
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	3.40	2.90	3.30	2.90	3.40	6.90
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	5.1	5.2	4.8	4.0	4.2	4.8
Mo	-	-	-	2.00	1.30	2.00	2.50	2.10	2.20
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NPL020 ELAK GRAD	NPL021 ELAK GRAD	NPL022 ELAK GRAD	NPL023 ELAK GRAD	NPL024 ELAK GRAD	NPL025 ELAK GRAD	NPL026 ELAK GRAD	NPL028 ELAK GRAD	NPM10 PMOU MONG
SiO_2	67.00	67.00	68.00	67.50	67.70	68.00	68.50	68.10	73.99
TiO_2	.60	.61	.61	.60	.61	.61	.61	.61	.14
Al_2O_3	15.01	14.92	14.90	14.95	14.93	14.92	14.93	14.97	14.76
Fe_2O_3	4.72	4.70	4.72	4.73	4.71	4.72	4.71	4.71	1.02
FeO	-	-	-	-	-	-	-	-	-
MnO	.09	.11	.09	.09	.10	.09	.09	.09	.02
MgO	1.32	1.40	1.31	1.26	1.34	1.28	1.34	1.32	.28
CaO	2.05	2.12	2.23	2.10	2.19	1.92	2.07	2.26	1.70
Na_2O	2.80	2.90	2.76	2.86	2.90	2.92	2.89	2.92	3.12
K_2O	4.28	3.92	4.08	4.29	4.15	4.13	4.06	4.25	4.48
P_2O_5	.19	.19	.19	.19	.19	.19	.18	.19	.06
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.35	1.31	.48	1.01	.91	-	1.12	.85	.38
TOTAL	99.41	99.18	99.37	99.58	99.73	98.78	100.50	100.27	99.95
Fe_2O_3t	4.72	4.70	4.72	4.73	4.71	4.72	4.71	4.71	1.02
A/CNK	1.2	1.2	1.1	1.1	1.1	1.2	1.2	1.1	1.1
DI	77.5	76.7	77.6	78.2	77.9	78.8	78.7	78.4	87.7
Ba	746.	620.	830.	740.	800.	950.	830.	680.	972.
Rb	187.	171.	144.	176.	162.	147.	167.	163.	77.
Sr	190.	160.	190.	200.	170.	170.	170.	240.	229.
Y	-	-	-	-	-	-	-	-	10.
Zr	-	-	-	-	-	-	-	-	53.
Nb	-	-	-	-	-	-	-	-	6.
Th	13.00	18.00	14.00	15.00	15.00	17.00	16.00	14.00	1.00
Pb	16.	33.	30.	33.	14.	18.	16.	18.	29.
Ga	-	-	-	-	-	-	-	-	14.
Zn	59.0	83.0	59.0	69.0	80.0	77.0	67.0	75.0	16.0
Cu	13.0	16.0	104.0	13.0	14.0	19.0	12.0	12.0	-
Ni	-	-	-	-	-	-	-	-	3.0
TiO_2	-	-	-	-	-	-	-	-	.18
V	-	-	-	-	-	-	-	-	16.
Cr	-	-	-	-	-	-	-	-	12.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	89.0	83.0	90.0	87.0	92.0	76.0	80.0	74.0	-
Be	-	-	-	-	-	-	-	-	-
B	61.0	37.0	48.0	31.0	13.0	27.0	37.0	15.0	-
F	540.	600.	580.	600.	600.	520.	560.	620.	-
Cl	-	-	-	-	-	-	-	-	-
U	3.60	3.80	3.80	3.90	3.20	3.30	4.60	3.30	-
W	-	-	-	-	-	-	-	-	-
Sn	5.0	5.0	4.5	4.7	4.0	4.8	4.7	4.3	-
Mo	2.20	1.50	2.80	1.50	2.00	1.70	2.00	1.40	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NPM11 PMOU TONA	NPM17 PMOU GRAD	NPM2 PMOU TONA	NPM32 PMOU MONG	NPM361 PMOU LMON	NPM368B PMOU GRAD	NPM371 PMOU MONG	NPM440 PMOU GRAD	NPM441 PMOU MONG
SiO_2	67.23	70.09	70.78	73.30	75.07	72.96	75.72	68.15	73.72
TiO_2	.55	.42	.41	.14	.10	.24	.26	.52	.14
Al_2O_3	16.87	15.53	15.40	15.01	14.13	14.64	12.51	15.25	14.64
Fe_2O_3	3.86	2.79	3.16	1.21	.78	2.08	1.68	3.70	1.21
FeO	-	-	-	-	-	-	-	-	-
MnO	.06	.05	.06	.05	.02	.05	.04	.07	.04
MgO	1.40	.84	1.19	.30	.13	.47	.39	1.40	.26
CaO	3.23	2.17	2.09	.82	1.12	1.81	1.01	3.67	.83
Na_2O	3.62	4.18	3.92	3.87	4.10	4.35	2.72	3.68	3.92
K_2O	2.41	3.19	2.14	4.37	3.77	2.82	4.62	2.97	4.28
P_2O_5	.17	.30	.22	.31	.16	.22	.21	.20	.31
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.58	.41	.88	.65	.44	.42	.55	.52	.63
TOTAL	99.98	99.97	100.25	100.03	99.82	100.06	99.71	100.13	99.98
Fe_2O_3t	3.86	2.79	3.16	1.21	.78	2.08	1.68	3.70	1.21
A/CNK	1.2	1.1	1.2	1.2	1.1	1.1	1.1	1.0	1.2
DI	73.3	82.7	80.0	91.3	91.6	86.4	90.4	74.8	91.7
Ba	718.	645.	397.	374.	316.	316.	409.	494.	386.
Rb	82.	124.	74.	181.	125.	126.	170.	134.	189.
Sr	370.	184.	200.	64.	86.	106.	66.	207.	67.
Y	10.	20.	14.	14.	15.	20.	20.	17.	14.
Zr	150.	179.	127.	69.	70.	137.	99.	169.	73.
Nb	11.	13.	10.	12.	7.	10.	10.	11.	11.
Th	-	9.00	9.00	6.00	3.00	5.00	13.00	13.00	2.00
Pb	18.	26.	22.	26.	25.	16.	25.	12.	24.
Ga	18.	19.	18.	20.	15.	19.	19.	22.	21.
Zn	59.0	57.0	47.0	43.0	26.0	60.0	56.0	74.0	49.0
Cu	16.0	-	-	-	-	-	3.0	6.0	1.0
Ni	7.0	10.0	9.0	4.0	10.0	16.0	17.0	16.0	13.0
TiO_2	.73	.53	.47	.14	.08	.25	.28	.56	.13
V	68.	38.	52.	4.	4.	16.	11.	55.	7.
Cr	18.	20.	47.	9.	9.	12.	10.	42.	9.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NPM458 PMOU GRAD	NPM464 PMOU MOND	NPM469 PMOU GRAD	NPM472 PMOU MONG	NPM477 PMOU MONG	NPM484 PMOU GRAD	NPM487 PMOU TONA	NPM491 PMOU LTON	NPM511 PMOU MONG
SiO_2	72.26	69.03	70.16	73.35	72.61	73.83	70.33	73.94	73.48
TiO_2	.31	.48	.48	.13	.32	.13	.37	.02	.17
Al_2O_3	14.90	15.58	15.60	15.17	14.58	14.18	15.92	15.33	14.84
Fe_2O_3	2.13	3.03	2.63	1.11	1.83	3.00	3.09	.64	1.49
FeO	-	-	-	-	-	-	-	-	-
MnO	.05	.06	.04	.05	.04	.10	.05	.12	.04
MgO	.84	1.22	1.22	.66	.49	.66	1.03	.41	.32
CaO	1.88	2.21	1.38	.77	.85	1.62	2.74	.33	1.28
Na_2O	4.54	4.51	3.65	4.28	2.96	3.77	4.05	5.58	3.99
K_2O	2.29	2.80	3.92	4.03	5.18	2.11	1.94	2.45	3.74
P_2O_5	.17	.31	.21	.29	.27	.06	.17	.33	.21
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.20	.40	.70	.30	.73	.50	.61	.70	.55
TOTAL	99.57	99.63	99.99	100.14	99.86	99.96	100.30	99.85	100.11
Fe_2O_3t	2.13	3.03	2.63	1.11	1.83	3.00	3.09	.64	1.49
A/CNK	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
DI	84.2	81.1	83.8	91.2	89.4	83.9	78.2	93.2	89.2
Ba	364.	730.	823.	427.	696.	446.	440.	4.	261.
Rb	96.	137.	152.	179.	152.	65.	60.	165.	152.
Sr	139.	219.	161.	64.	113.	304.	312.	3.	70.
Y	22.	22.	14.	17.	16.	17.	20.	8.	16.
Zr	186.	202.	200.	66.	160.	108.	121.	32.	92.
Nb	10.	12.	7.	10.	9.	10.	9.	14.	10.
Th	9.00	7.00	38.00	7.00	27.00	24.00	6.00	4.00	5.00
Pb	16.	15.	22.	20.	27.	19.	24.	15.	21.
Ga	18.	20.	22.	17.	19.	16.	18.	20.	22.
Zn	49.0	63.0	81.0	44.0	50.0	40.0	43.0	43.0	53.0
Cu	2.0	6.0	6.0	-	3.0	3.0	2.0	-	-
Ni	9.0	12.0	9.0	16.0	14.0	6.0	10.0	8.0	12.0
TiO_2	.30	.49	.49	.13	.32	.11	.40	-	.17
V	18.	32.	34.	6.	13.	-	31.	1.	8.
Cr	14.	14.	24.	11.	8.	10.	15.	5.	7.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NPM533 PMOU TONA	NPM535 PMOU GRAD	NPM536 PMOU GRAD	NPM537 PMOU LMON	NPM538 PMOU MONG	NPM539 PMOU GRAD	NPM542 PMOU LMON	NPM543 PMOU GRAD	NPM544 PMOU TONA
SiO_2	63.65	71.33	71.77	74.56	74.50	71.32	74.26	64.24	67.53
TiO_2	.68	.32	.25	.09	.09	.36	.11	.76	.51
Al_2O_3	17.67	15.27	15.20	14.22	14.69	15.57	14.65	17.78	16.22
Fe_2O_3	4.64	2.19	1.97	.77	.81	2.41	.73	3.69	3.44
FeO	-	-	-	-	-	-	-	-	-
MnO	.09	.05	.06	.02	.02	.06	.02	.05	.08
MgO	2.02	1.04	.86	.16	.34	.89	.51	1.91	1.62
CaO	4.02	1.61	1.59	1.25	.92	2.14	.92	3.27	2.77
Na_2O	3.97	4.08	4.66	3.84	3.35	4.35	4.49	4.42	4.10
K_2O	2.12	3.45	3.13	4.44	4.75	2.87	3.62	2.47	2.12
P_2O_5	.19	.21	.24	.11	.14	.19	.13	.24	.19
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.30	.40	.40	.27	.56	.37	.30	.50	.70
TOTAL	99.35	99.95	100.13	99.73	100.17	100.53	99.74	99.33	99.28
Fe_2O_3t	4.64	2.19	1.97	.77	.81	2.41	.73	3.69	3.44
A/CNK	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.2
DI	67.5	84.9	86.6	91.4	91.2	83.4	91.3	71.9	75.0
Ba	601.	383.	316.	460.	244.	399.	451.	683.	484.
Rb	71.	139.	137.	143.	133.	128.	132.	112.	128.
Sr	474.	124.	102.	111.	63.	151.	84.	278.	337.
Y	17.	15.	17.	15.	11.	16.	10.	17.	20.
Zr	182.	115.	117.	76.	39.	128.	47.	220.	141.
Nb	12.	9.	11.	5.	8.	9.	6.	7.	10.
Th	-	12.00	7.00	9.00	2.00	11.00	3.00	28.00	13.00
Pb	8.	17.	19.	22.	24.	22.	18.	11.	17.
Ga	22.	22.	19.	16.	21.	22.	18.	26.	23.
Zn	61.0	57.0	60.0	23.0	23.0	57.0	29.0	88.0	65.0
Cu	7.0	6.0	-	-	-	-	-	4.0	4.0
Ni	10.0	9.0	9.0	8.0	9.0	13.0	6.0	10.0	14.0
TiO_2	.76	.32	.24	.08	.05	.34	.10	.78	.57
V	77.	27.	15.	3.	1.	30.	3.	71.	58.
Cr	21.	21.	13.	3.	6.	25.	8.	47.	24.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NPM545 PMOU GRAD	NPM546 PMOU LTON	NPM548 PMOU MONG	NPM549 PMOU GRAD	NPM551 PMOU MONG	NPM556 PMOU MONG	NPM558 PMOU GRAD	NPM560 PMOU TONA	NPM563 PMOU GRAD
SiO2	69.28	63.53	72.73	67.10	68.49	70.33	68.27	70.27	71.12
TiO2	.43	.36	.21	.65	.42	.46	.60	.35	.32
Al2O3	15.75	20.13	15.10	16.42	15.98	15.25	16.24	15.76	15.18
Fe2O3	3.15	2.33	1.39	3.31	2.85	2.61	3.27	2.54	2.25
FeO	-	-	-	-	-	-	-	-	-
MnO	.05	.05	.04	.05	.06	.04	.04	.07	.04
MgO	1.00	1.25	.75	1.70	1.43	1.02	1.33	.77	.71
CaO	2.47	4.13	.87	2.46	2.35	1.74	2.27	2.81	1.92
Na2O	4.18	5.82	3.99	3.94	3.97	3.56	3.76	4.44	4.07
K2O	2.31	1.54	4.22	3.42	3.69	4.24	3.66	2.25	3.49
P2O5	.32	.14	.23	.21	.16	.22	.21	.22	.23
H2O+	-	-	-	-	-	-	-	-	-
H2O-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.40	.60	.30	.30	.30	.46	.72	.42	.50
TOTAL	99.34	99.88	99.83	99.56	99.70	99.93	100.37	99.90	99.83
Fe2O3t	3.15	2.33	1.39	3.31	2.85	2.61	3.27	2.54	2.25
A/CNK	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1	1.1
DI	79.3	71.8	89.7	77.4	80.0	83.9	79.6	80.2	84.6
Ba	318.	175.	334.	929.	812.	781.	901.	283.	546.
Rb	112.	75.	186.	139.	121.	166.	137.	98.	123.
Sr	130.	389.	70.	223.	330.	163.	226.	184.	157.
Y	24.	11.	15.	15.	18.	16.	17.	15.	17.
Zr	229.	123.	88.	206.	123.	151.	217.	210.	146.
Nb	12.	8.	9.	8.	10.	7.	8.	10.	10.
Th	10.00	10.00	12.00	32.00	3.00	26.00	44.00	-	8.00
Pb	13.	14.	22.	15.	13.	22.	21.	17.	23.
Ga	19.	22.	21.	23.	19.	26.	25.	22.	20.
Zn	83.0	50.0	51.0	91.0	47.0	83.0	90.0	60.0	59.0
Cu	3.0	7.0	-	10.0	5.0	4.0	8.0	4.0	1.0
Ni	11.0	6.0	10.0	10.0	11.0	16.0	14.0	9.0	11.0
TiO2	.42	.38	.20	.64	.48	.50	.61	.34	.32
V	37.	36.	14.	53.	52.	38.	45.	27.	21.
Cr	13.	32.	16.	32.	19.	20.	33.	12.	21.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NPM565 PMOU GRAD	NPM566 PMOU MONG	NPM578 PMOU MONG	NPM579 PMOU GRAD	NPM580 PMOU LMON	NPM581 PMOU GRAD	NPM582 PMOU TONA	NPM583 PMOU TONA	NPM584 PMOU TONA
SiO_2	70.01	72.72	70.93	72.64	72.79	71.45	66.24	72.85	68.14
TiO_2	.35	.22	.29	.26	.14	.32	.63	.35	.50
Al_2O_3	15.62	14.64	15.31	14.61	14.89	15.61	17.00	15.02	16.25
Fe_2O_3	2.53	1.47	2.16	1.47	.96	2.29	3.76	2.38	3.86
FeO	–	–	–	–	–	–	–	–	–
MnO	.05	.03	.04	.03	.03	.06	.07	.04	.07
MgO	1.18	.34	.97	.34	.30	.95	1.56	.72	1.46
CaO	2.05	.86	1.88	.86	.85	1.76	3.94	2.35	3.12
Na_2O	4.41	2.85	4.21	2.85	2.56	4.63	3.94	3.58	4.02
K_2O	2.90	5.86	3.17	5.86	6.30	3.09	1.55	2.19	1.73
P_2O_5	.14	.18	.20	.18	.32	.27	.30	.15	.13
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	.40	.47	.40	.47	.61	.50	.50	.64	.50
TOTAL	99.64	99.64	99.56	99.57	99.75	100.93	99.49	100.27	99.78
Fe_2O_3t	2.53	1.47	2.16	1.47	.96	2.29	3.76	2.38	3.86
A/CNK	1.1	1.2	1.1	1.2	1.2	1.1	1.1	1.2	1.2
DI	81.9	90.6	83.8	90.5	91.3	85.7	70.0	81.2	73.9
Ba	400.	963.	497.	598.	774.	461.	314.	657.	475.
Rb	112.	157.	130.	150.	234.	156.	59.	69.	62.
Sr	225.	118.	137.	152.	102.	116.	213.	197.	385.
Y	17.	16.	19.	13.	19.	19.	27.	22.	11.
Zr	102.	112.	140.	137.	60.	151.	389.	209.	156.
Nb	13.	10.	9.	9.	8.	10.	11.	8.	9.
Th	5.00	14.00	3.00	14.00	1.00	13.00	4.00	12.00	10.00
Pb	15.	29.	17.	26.	21.	18.	13.	18.	16.
Ga	21.	22.	20.	20.	20.	21.	18.	19.	18.
Zn	57.0	44.0	56.0	54.0	33.0	61.0	66.0	53.0	54.0
Cu	2.0	–	–	1.0	3.0	–	19.0	1.0	8.0
Ni	9.0	13.0	12.0	13.0	18.0	13.0	8.0	4.0	2.0
TiO_2	.37	.21	.28	.26	.13	.36	.61	.37	.49
V	37.	5.	24.	19.	6.	24.	50.	24.	37.
Cr	18.	7.	14.	16.	8.	20.	16.	14.	14.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NPM593 PMOU GRAD	NPM8B PMOU LMON	NPS122 SHER MONG	NPS124 SHER MONG	NPS126 SHER MONG	NPS200 SHER MONG	NPS205 SHER MONG	NSH205 SHEL GRAD	NSH213 SHEL GRAD
SiO_2	70.20	73.09	72.21	73.86	75.00	72.65	73.35	70.66	74.78
TiO_2	.47	.04	.20	.14	.11	.05	.13	.54	.11
Al_2O_3	15.69	15.50	14.30	15.11	14.53	15.26	14.48	14.81	14.44
Fe_2O_3	2.59	1.07	.26	.22	.16	.24	.17	2.52	1.16
FeO	-	-	1.17	1.01	.59	.61	.83	-	-
MnO	.05	.22	.02	.03	.02	.02	.02	.05	.04
MgO	1.22	.08	.51	.08	.27	.16	.27	.86	.20
CaO	1.30	.37	.66	.53	.62	.49	.64	.94	.63
Na_2O	3.94	3.10	3.66	3.68	3.81	4.07	3.88	3.23	3.36
K_2O	3.32	5.69	4.53	4.23	5.11	4.17	4.55	4.28	4.39
P_2O_5	.20	.15	.22	.22	.16	.31	.25	.22	.19
H_2O+	-	-	.81	.81	.43	.70	.71	-	-
H_2O-	-	-	.07	.01	.01	.01	.01	-	-
CO_2	-	-	.16	.04	.11	.28	.22	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.70	.74	-	-	-	-	-	.92	.76
TOTAL	99.68	100.05	98.78	99.97	100.93	99.02	99.51	99.03	100.06
Fe_2O_3t	2.59	1.07	1.56	1.34	.81	.92	1.09	2.52	1.16
A/CNK	1.3	1.3	1.2	1.3	1.1	1.3	1.2	1.3	1.3
DI	83.5	92.6	90.0	91.9	94.6	92.2	92.3	85.4	91.7
Ba	768.	181.	390.	110.	430.	12.	10.	782.	592.
Rb	115.	178.	242.	216.	199.	305.	210.	116.	82.
Sr	194.	30.	75.	54.	97.	11.	36.	356.	308.
Y	13.	11.	-	-	-	-	-	10.	20.
Zr	190.	37.	-	-	-	-	-	239.	183.
Nb	9.	10.	-	-	-	-	-	11.	15.
Th	35.00	2.00	5.00	4.00	2.00	2.00	4.00	2.60	5.10
Pb	26.	36.	17.	16.	30.	7.	16.	15.	17.
Ga	20.	19.	-	-	-	-	-	19.	21.
Zn	58.0	18.0	54.0	49.0	26.0	40.0	38.0	66.0	74.0
Cu	-	-	5.0	7.0	6.0	5.0	5.0	-	-
Ni	7.0	5.0	-	-	-	-	-	16.0	20.0
TiO_2	.49	.03	-	-	-	-	-	-	-
V	36.	-	-	-	-	-	-	121.	93.
Cr	19.	9.	-	-	-	-	-	102.	111.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	187.0	104.0	61.0	263.0	103.0	85.0	72.0
Be	-	-	6.0	11.0	8.3	7.5	9.0	4.9	3.2
B	-	-	12.0	8.0	5.0	8.0	9.0	-	-
F	-	-	500.	500.	300.	700.	500.	520.	180.
Cl	-	-	-	-	-	-	-	-	-
U	-	-	3.60	3.20	1.60	9.40	2.90	6.30	3.10
W	-	-	4.0	4.0	4.0	4.0	4.0	-	-
Sn	-	-	14.0	9.0	6.5	35.0	8.0	10.0	6.0
Mo	-	-	2.10	1.50	1.50	2.20	1.30	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NSH230 SHEL GRAD	NSH252 SHEL GRAD	NSH255 SHEL TONA	NSH263 SHEL GRAD	NSH269 SHEL GRAD	NSH270 SHEL GRAD	NSH331 SHEL GRAD	NSH422 SHEL GRAD	NSH423 SHEL GRAD
SiO_2	74.45	73.82	67.74	73.61	74.43	73.10	74.26	73.61	72.03
TiO_2	.10	.24	.55	.25	.14	.17	.25	.30	.27
Al_2O_3	14.35	14.27	16.51	14.40	14.47	14.35	13.83	14.47	15.37
Fe_2O_3	1.16	1.14	3.09	1.61	.83	1.46	1.05	1.54	2.25
FeO	-	-	-	-	-	-	-	-	-
MnO	.04	.03	.05	.06	.04	.03	.03	.06	.06
MgO	.17	.28	1.41	.43	.18	.24	.24	.47	.56
CaO	.59	.44	3.32	1.25	.36	1.98	.48	1.71	1.95
Na_2O	3.35	3.22	4.47	3.87	3.81	3.44	3.21	4.22	4.19
K_2O	4.47	5.07	1.81	3.47	4.39	4.17	4.83	2.47	2.21
P_2O_5	.33	.27	.10	.25	.36	.14	.20	.10	.16
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.93	.92	.70	.69	.73	.67	.79	.73	.75
TOTAL	99.94	99.70	99.75	99.89	99.74	99.75	99.17	99.68	99.80
Fe_2O_3t	1.16	1.14	3.09	1.61	.83	1.46	1.05	1.54	2.25
A/CNK	1.3	1.2	1.1	1.2	1.2	1.0	1.2	1.1	1.2
DI	92.0	92.3	74.4	88.4	93.4	86.7	92.0	85.8	83.2
Ba	475.	640.	457.	351.	427.	562.	728.	437.	467.
Rb	127.	195.	53.	147.	160.	85.	161.	89.	88.
Sr	63.	125.	484.	85.	48.	106.	81.	167.	156.
Y	14.	13.	10.	16.	12.	14.	19.	14.	16.
Zr	50.	190.	120.	111.	34.	70.	96.	111.	127.
Nb	9.	6.	5.	9.	10.	8.	8.	7.	8.
Th	5.40	5.00	1.50	6.30	6.50	3.70	4.60	3.80	3.80
Pb	27.	20.	13.	22.	23.	28.	29.	22.	17.
Ga	17.	21.	19.	17.	16.	16.	16.	18.	18.
Zn	42.0	91.0	55.0	56.0	38.0	33.0	42.0	41.0	54.0
Cu	-	-	-	-	-	-	-	-	-
Ni	2.0	9.0	3.0	4.0	4.0	1.0	2.0	2.0	-
TiO_2	-	-	-	-	-	-	-	-	-
V	1.	38.	65.	10.	2.	3.	5.	17.	16.
Cr	36.	63.	44.	43.	50.	31.	22.	32.	19.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	60.0	62.0	42.0	262.0	105.0	53.0	57.0	67.0	91.0
Be	4.9	3.2	2.8	2.8	5.1	2.0	1.5	3.7	5.5
B	-	-	-	-	-	-	-	-	-
F	220.	410.	380.	290.	240.	150.	250.	250.	220.
Cl	-	-	-	-	-	-	-	-	-
U	4.10	5.80	1.80	9.90	4.70	3.50	5.90	3.90	3.90
W	-	-	-	-	-	-	-	-	-
Sn	3.0	31.0	3.0	9.0	2.0	8.0	16.0	9.0	8.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NSH427 SHEL GRAD	NSH428 SHEL GRAD	NSH430 SHEL TONA	NSH501 SHEL GRAD	NSH508 SHEL GRAD	NSH519 SHEL TONA	NSH521 SHEL GRAD	NSH522 SHEL TONA	NSH583 SHEL GRAD
SiO_2	73.09	72.54	67.17	73.52	73.35	67.41	74.31	65.99	74.30
TiO_2	.32	.21	.35	.17	.06	.55	.24	.60	.17
Al_2O_3	14.08	13.71	20.18	14.36	15.11	16.41	13.81	17.09	13.94
Fe_2O_3	1.80	1.74	2.33	1.41	.90	3.87	1.90	3.91	1.49
FeO	-	-	-	-	-	-	-	-	-
MnO	.05	.06	.07	.05	.06	.06	.04	.06	.04
MgO	.45	.66	1.02	.17	.24	1.19	.28	1.46	.17
CaO	1.24	.74	5.19	.65	.66	3.25	.64	3.56	.61
Na_2O	3.42	3.20	4.69	3.38	3.94	4.62	2.65	4.47	3.17
K_2O	4.30	5.11	1.19	4.83	3.92	1.55	5.29	1.69	4.68
P_2O_5	.18	.23	.18	.33	.15	.15	.12	.14	.17
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.58	.88	.53	.68	.81	.69	.82	.67	.79
TOTAL	99.51	99.08	102.90	99.55	99.20	99.75	100.10	99.64	99.53
Fe_2O_3t	1.80	1.74	2.33	1.41	.90	3.87	1.90	3.91	1.49
A/CNK	1.1	1.1	1.1	1.2	1.3	1.1	1.2	1.1	1.2
DI	88.3	89.7	69.9	91.8	90.6	74.5	90.9	71.9	91.3
Ba	783.	776.	245.	500.	287.	399.	767.	456.	589.
Rb	176.	204.	49.	210.	138.	61.	161.	56.	181.
Sr	116.	74.	274.	55.	58.	556.	126.	565.	74.
Y	18.	22.	13.	22.	12.	8.	25.	11.	15.
Zr	175.	105.	159.	72.	38.	124.	80.	142.	76.
Nb	9.	9.	7.	9.	8.	6.	8.	6.	10.
Th	4.70	6.00	1.80	6.00	5.30	3.10	4.00	2.10	4.80
Pb	23.	34.	11.	25.	25.	9.	31.	14.	29.
Ga	16.	17.	23.	15.	16.	21.	15.	20.	18.
Zn	57.0	75.0	52.0	50.0	28.0	57.0	45.0	51.0	46.0
Cu	-	-	-	-	-	-	-	-	-
Ni	5.0	11.0	2.0	6.0	3.0	9.0	5.0	9.0	3.0
TiO_2	-	-	-	-	-	-	-	-	-
V	19.	11.	37.	-	84.	54.	8.	75.	5.
Cr	40.	40.	37.	29.	74.	57.	50.	77.	40.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	96.0	38.0	93.0	155.0	68.0	81.0	30.0	68.0	73.0
Be	3.9	2.8	-	4.1	-	.9	3.5	2.3	3.4
B	-	-	-	-	-	-	-	-	-
F	380.	260.	280.	260.	180.	410.	260.	430.	240.
Cl	-	-	-	-	-	-	-	-	-
U	6.20	5.70	3.10	8.50	2.90	1.50	7.70	1.10	2.80
W	-	-	-	-	-	-	-	-	-
Sn	23.0	12.0	1.0	11.0	4.0	1.0	13.0	2.0	14.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NSH729 SHEL GRAD	NSH794 SHEL GRAD	NSH796 SHEL GRAD	NSHA26 SHEL GRAD	NSHA27 SHEL GRAD	NSHA34 SHEL GRAD	NSHA35 SHEL GRAD	NSHA84 SHEL GRAD	NSI749 SISL MONG
SiO_2	72.90	73.64	74.50	72.30	72.74	73.10	72.70	74.50	72.66
TiO_2	.26	.11	.09	.16	.37	.21	.17	.06	.35
Al_2O_3	14.88	15.32	14.90	15.10	14.64	14.40	15.10	14.30	14.30
Fe_2O_3	1.86	1.61	1.37	1.48	1.65	1.58	1.37	.74	2.85
FeO	-	-	-	-	-	-	-	-	-
MnO	.05	.05	.04	.04	.04	.05	.03	-	.05
MgO	.54	.53	.31	.56	.54	.54	.39	.23	.42
CaO	.85	1.50	.57	1.59	.70	1.64	1.80	.40	.68
Na_2O	3.59	4.43	3.48	5.11	3.27	4.30	4.80	4.43	3.41
K_2O	4.24	2.52	4.75	2.05	4.53	3.05	2.69	4.05	4.48
P_2O_5	.22	.22	.27	.21	.26	.16	.13	.17	.12
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.91	.47	.57	.54	.98	1.16	.77	1.16	.52
TOTAL	100.30	100.40	100.85	99.14	99.72	100.19	99.95	100.04	99.84
Fe_2O_3t	1.86	1.61	1.37	1.48	1.65	1.58	1.37	.74	2.85
A/CNK	1.2	1.2	1.3	1.1	1.3	1.1	1.1	1.2	1.2
DI	89.2	87.2	92.7	86.4	89.3	87.0	86.9	93.9	89.3
Ba	388.	659.	405.	250.	-	360.	560.	190.	712.
Rb	277.	78.	159.	80.	-	130.	90.	200.	132.
Sr	82.	249.	58.	120.	-	190.	260.	40.	195.
Y	11.	21.	15.	-	-	-	-	-	17.
Zr	132.	127.	82.	-	-	100.	80.	-	201.
Nb	7.	7.	9.	-	-	-	-	-	17.
Th	4.40	.70	4.10	-	-	-	-	2.00	1.80
Pb	18.	26.	29.	-	-	-	6.	6.	19.
Ga	23.	12.	16.	-	-	-	-	-	19.
Zn	74.0	29.0	38.0	-	-	36.0	36.0	5.0	42.0
Cu	-	-	-	-	-	-	-	-	-
Ni	7.0	8.0	-	-	-	-	.5	3.0	6.0
TiO_2	-	-	-	-	-	-	-	-	-
V	15.	14.	3.	-	-	-	-	-	27.
Cr	26.	26.	27.	-	-	-	-	110.	33.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	118.0	43.0	54.0	110.0	-	72.0	89.0	99.0	45.0
Be	-	-	-	-	-	-	-	-	3.9
B	-	-	-	-	-	-	-	-	-
F	60.	220.	180.	310.	-	410.	330.	290.	410.
Cl	-	-	-	-	-	-	-	-	-
U	5.60	3.90	5.10	-	-	-	3.80	3.60	3.50
W	-	-	-	-	-	-	-	-	-
Sn	24.0	9.0	12.0	-	-	-	5.0	7.0	11.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NSI751 SISL MONG	NSI753 SISL MONG	NSI758 SISL MONG	NSI761 SISL MONG	NSL001 SLAK MONG	NSL003 SLAK MONG	NSL004 SLAK MONG	NSL005 SLAK MONG	NSL006 SLAK MONG
SiO_2	73.98	73.54	74.35	72.11	72.62	72.30	72.41	72.86	72.99
TiO_2	.23	.17	.25	.29	.11	.11	.16	.12	.17
Al_2O_3	13.98	14.40	14.32	14.47	15.05	15.31	15.09	14.92	14.99
Fe_2O_3	1.76	1.98	1.69	.47	.10	.11	.44	.11	.11
FeO	-	-	-	-	1.02	1.03	1.05	1.02	1.33
MnO	.03	.04	.30	.06	.05	.05	.05	.05	.04
MgO	.26	.31	.21	.56	.24	.25	.34	.25	.35
CaO	.74	.57	.50	1.45	.61	.44	.47	.50	.43
Na_2O	3.69	3.26	3.16	3.57	4.14	4.06	3.91	4.03	3.89
K_2O	4.24	4.53	4.42	4.12	3.76	3.84	3.97	3.69	3.94
P_2O_5	.21	.22	.19	.12	.62	.48	.47	.51	.50
H_2O+	-	-	-	-	1.23	1.15	.95	1.02	.92
H_2O-	-	-	-	-	.12	.20	.11	.09	.14
CO_2	-	-	-	-	.19	.15	.19	.19	.09
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.75	.76	.77	.48	-	-	-	-	-
TOTAL	99.87	99.78	100.16	97.70	99.86	99.48	99.61	99.36	99.89
Fe_2O_3t	1.76	1.98	1.69	.47	1.23	1.25	1.61	1.24	1.59
A/CNK	1.2	1.3	1.3	1.1	1.3	1.3	1.3	1.3	1.3
DI	91.2	90.5	91.1	86.5	91.7	91.3	91.0	91.3	91.0
Ba	565.	672.	516.	496.	26.	17.	24.	21.	26.
Rb	165.	186.	185.	163.	432.	391.	347.	375.	293.
Sr	85.	99.	73.	160.	72.	32.	33.	29.	17.
Y	20.	27.	16.	25.	-	-	-	-	-
Zr	156.	149.	114.	182.	42.	40.	57.	48.	57.
Nb	20.	18.	19.	19.	-	-	-	-	-
Th	5.40	5.10	5.70	4.30	3.00	3.00	5.00	4.00	4.00
Pb	16.	22.	18.	22.	14.	16.	19.	17.	17.
Ga	25.	24.	26.	20.	-	-	-	-	-
Zn	67.0	52.0	48.0	47.0	43.0	52.0	69.0	57.0	59.0
Cu	-	-	-	-	-	-	-	-	-
Ni	7.0	13.0	5.0	8.0	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	12.	8.	3.	22.	-	-	-	-	-
Cr	41.	32.	40.	34.	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	34.0	92.0	69.0	77.0	248.0	246.0	252.0	228.0	217.0
Be	4.6	-	3.7	3.4	12.5	9.0	14.0	13.0	7.5
B	-	-	-	-	20.0	30.0	30.0	20.0	25.0
F	600.	870.	600.	360.	760.	700.	500.	635.	610.
Cl	-	-	-	-	-	-	-	-	-
U	3.00	8.80	5.20	4.50	16.00	13.90	13.40	13.80	10.00
W	-	-	-	-	4.0	10.0	5.0	3.0	4.0
Sn	11.0	10.0	11.0	17.0	19.0	21.0	22.0	20.0	12.0
Mo	-	-	-	-	2.00	2.00	1.00	1.00	1.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NSL007 SLAK MONG	NSL008 SLAK MONG	NSL009 SLAK MONG	NSL010 SLAK MONG	NSL011 SLAK MONG	NSL012 SLAK MONG	NSL013 SLAK MONG	NSL014 SLAK MONG	NSL015 SLAK MONG
SiO_2	75.07	73.25	73.55	73.06	72.19	72.21	72.68	71.82	73.00
TiO_2	.17	.03	.07	.15	.29	.23	.21	.24	.17
Al_2O_3	13.87	15.05	15.27	15.36	15.43	15.34	15.27	15.83	15.11
Fe_2O_3	.05	–	.09	.14	.41	.31	.19	.69	–
FeO	.91	.45	.37	1.26	1.50	1.39	1.39	1.35	1.22
MnO	.03	.03	.04	.06	.05	.07	.06	.07	.05
MgO	.29	.05	.06	.29	.49	.40	.39	.48	.28
CaO	.62	.47	.63	.48	.47	.46	.46	.42	.48
Na_2O	4.55	4.58	4.89	4.03	3.59	3.89	3.82	3.80	4.08
K_2O	3.31	3.58	3.38	3.95	4.13	3.98	4.03	4.33	3.81
P_2O_5	.28	.62	.75	.50	.34	.43	.39	.32	.49
H_2O+	.60	.60	.52	.93	.79	.97	.73	.80	.63
H_2O-	.10	.17	.12	.14	.19	.20	.10	.13	.16
CO_2	.15	.19	.10	.17	.13	.08	.13	.01	.07
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	100.00	99.07	99.84	100.52	100.00	99.96	99.85	100.29	99.55
Fe_2O_3t	1.06	.50	.50	1.54	2.08	1.85	1.73	2.19	1.35
A/CNK	1.1	1.2	1.2	1.3	1.4	1.3	1.3	1.4	1.3
DI	93.2	93.3	93.9	91.7	89.6	90.4	90.5	90.3	91.2
Ba	261.	14.	38.	72.	52.	26.	34.	28.	20.
Rb	191.	423.	506.	385.	267.	339.	294.	357.	367.
Sr	79.	95.	53.	57.	22.	19.	17.	17.	51.
Y	–	–	–	–	–	–	–	–	–
Zr	61.	20.	18.	100.	78.	61.	62.	94.	45.
Nb	–	–	–	–	–	–	–	–	–
Th	5.00	1.00	2.00	3.00	7.00	5.00	4.00	6.00	6.00
Pb	26.	13.	11.	8.	20.	19.	18.	18.	17.
Ga	–	–	–	–	–	–	–	–	–
Zn	39.0	16.0	25.0	75.0	80.0	81.0	72.0	94.0	63.0
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	95.0	64.0	60.0	271.0	135.0	234.0	210.0	263.0	246.0
Be	3.0	29.5	50.0	23.0	4.5	5.0	4.5	4.5	7.5
B	25.0	25.0	9.0	15.0	20.0	25.0	40.0	20.0	65.0
F	220.	236.	310.	660.	570.	570.	570.	700.	700.
Cl	–	–	–	–	–	–	–	–	–
U	3.90	23.00	16.40	15.40	12.20	17.60	10.90	20.10	15.50
W	4.0	1.0	4.0	4.0	4.0	4.0	5.0	5.0	5.0
Sn	1.0	25.0	15.0	19.0	9.0	14.0	11.0	15.0	20.0
Mo	1.00	1.00	.70	1.00	1.00	1.00	1.00	1.00	1.00
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NSL018 SLAK MONG	NSL022 SLAK MONG	NSL024 SLAK MONG	NTS803 HALI ALAS	NTS804 HALI ALAS	NTS805 HALI ALAS	NTS806 HALI ALAS	NTS812 HALI MONG	NTS813 HALI MONG
SiO_2	73.41	73.19	74.38	75.80	76.43	75.81	78.13	74.14	75.33
TiO_2	.10	.02	.03	.16	.17	.17	.18	.31	.20
Al_2O_3	14.95	14.81	14.60	12.71	12.83	12.86	11.39	13.44	13.37
Fe_2O_3	.09	–	–	1.41	1.24	1.82	1.69	2.38	1.76
FeO	.92	.52	.58	–	–	–	–	–	–
MnO	.03	.06	.05	.04	.03	.05	.06	.05	.05
MgO	.28	.10	.06	.16	.18	.35	.29	.44	.25
CaO	.56	.50	.77	.39	.39	.56	.46	.74	.55
Na_2O	3.51	4.67	4.65	3.09	3.36	3.39	2.21	3.53	3.69
K_2O	5.23	3.61	3.15	4.59	4.33	4.61	4.10	4.48	4.28
P_2O_5	.27	.33	.87	.17	.18	.18	.17	.25	.23
H_2O+	.48	.56	.56	–	–	–	–	–	–
H_2O-	.25	.18	.17	–	–	–	–	–	–
CO_2	.11	.19	.10	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	.81	.95	.78	.64	.50	.89
TOTAL	100.19	98.74	99.97	99.33	100.09	100.58	99.32	100.26	100.60
Fe_2O_3t	1.11	.58	.64	1.41	1.24	1.82	1.69	2.38	1.76
A/CNK	1.2	1.2	1.2	1.2	1.2	1.1	1.3	1.1	1.1
DI	92.8	93.2	93.4	92.9	93.7	93.2	91.6	91.3	93.1
Ba	371.	11.	8.	74.	67.	78.	58.	184.	35.
Rb	208.	315.	441.	232.	228.	262.	234.	267.	300.
Sr	99.	12.	88.	18.	16.	25.	21.	56.	20.
Y	–	–	–	23.	18.	13.	19.	17.	12.
Zr	57.	19.	15.	71.	72.	63.	64.	112.	63.
Nb	–	–	–	9.	10.	8.	9.	14.	13.
Th	4.00	1.00	1.00	–	–	–	–	–	–
Pb	30.	15.	14.	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	44.0	12.0	15.0	–	–	21.0	12.0	26.0	13.0
Cu	–	–	–	4.0	2.0	–	4.0	4.0	1.0
Ni	–	–	–	2.0	2.0	2.0	3.0	3.0	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	11.	11.	10.	11.	21.	12.
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	2.	–	1.	1.	2.	1.
Li	92.0	69.0	47.0	–	–	–	–	–	–
Be	5.5	5.5	12.5	–	–	–	–	–	–
B	15.0	20.0	20.0	–	–	–	–	–	–
F	310.	370.	760.	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	4.60	9.90	15.50	–	–	–	–	–	–
W	4.0	2.0	1.0	–	–	–	–	–	–
Sn	2.0	30.0	27.0	1.0	2.0	3.0	5.0	–	4.0
Mo	2.00	2.00	2.00	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NTS814 HALI MONG	NTS815 HALI MONG	NTS816 HALI MONG	NTS817 HALI MONG	NTS818 HALI MONG	NTS819 HALI MONG	NTS820 HALI MONG	NTS821 HALI MONG	NTS822 HALI MONG
SiO_2	73.13	74.03	72.31	72.64	73.49	74.92	71.74	71.96	72.41
TiO_2	.34	.24	.32	.30	.32	.26	.34	.31	.18
Al_2O_3	13.41	13.32	13.72	13.69	13.46	12.96	13.65	13.39	14.12
Fe_2O_3	2.44	1.75	2.28	2.27	2.40	1.88	2.44	2.34	1.47
FeO	-	-	-	-	-	-	-	-	-
MnO	.04	.04	.05	.04	.05	.05	.04	.05	.04
MgO	.46	.11	.42	.31	.54	.36	.45	.34	.70
CaO	.87	.63	.96	.85	.85	.82	.85	.70	.65
Na_2O	3.29	3.67	3.68	3.36	3.44	3.37	3.49	3.52	3.49
K_2O	4.33	4.47	4.48	4.10	3.99	4.08	4.58	4.46	4.43
P_2O_5	.23	.21	.22	.26	.26	.25	.23	.22	.32
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.81	1.02	.77	1.12	1.08	.93	.89	1.04	1.13
TOTAL	99.35	99.49	99.21	98.94	99.88	99.88	98.70	98.33	98.94
Fe_2O_3t	2.44	1.75	2.28	2.27	2.40	1.88	2.44	2.34	1.47
A/CNK	1.2	1.1	1.1	1.2	1.2	1.1	1.1	1.1	1.2
DI	89.0	92.1	89.3	88.5	89.0	90.7	88.7	89.2	89.3
Ba	63.	240.	276.	201.	204.	206.	279.	244.	269.
Rb	250.	258.	249.	241.	235.	224.	240.	253.	218.
Sr	27.	62.	69.	59.	60.	57.	76.	66.	52.
Y	13.	17.	17.	16.	17.	14.	17.	17.	12.
Zr	77.	130.	124.	106.	120.	93.	127.	115.	56.
Nb	12.	15.	14.	13.	15.	11.	13.	13.	10.
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	6.0	35.0	35.0	37.0	34.0	22.0	27.0	36.0	5.0
Cu	-	4.0	-	1.0	2.0	3.0	34.0	23.0	13.0
Ni	1.0	4.0	1.0	1.0	3.0	3.0	2.0	2.0	2.0
TiO_2	-	-	-	-	-	-	-	-	-
V	16.	26.	27.	23.	24.	20.	27.	24.	11.
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	3.	1.	4.	3.	4.	2.	5.	3.	1.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	2.0	3.0	-	3.0	3.0	2.0	3.0	4.0	6.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NTS823 HALI MONG	NTS824 HALI MONG	NTS825 HALI MONG	NTS826 HALI MONG	NTS827 HALI MONG	NTS828 HALI MONG	NTS829 HALI MONG	NTS830 HALI ALAS	NTS831 HALI ALAS
SiO_2	71.97	75.28	72.68	75.28	75.47	73.64	75.02	74.71	75.05
TiO_2	.18	.15	.18	.16	.14	.16	.13	.11	.11
Al_2O_3	14.10	13.74	14.58	13.16	13.44	13.39	13.76	13.90	13.78
Fe_2O_3	1.54	1.52	1.51	1.81	1.43	1.84	1.43	1.44	1.62
FeO	-	-	-	-	-	-	-	-	-
MnO	.04	.04	.03	.05	.04	.06	.05	.04	.04
MgO	.24	.04	.05	.07	.15	.09	.08	.05	.18
CaO	.62	.47	.65	.48	.56	.61	.55	.44	.43
Na_2O	3.54	3.44	3.99	3.54	3.41	3.59	3.42	3.68	3.72
K_2O	4.48	4.07	4.66	4.25	4.40	4.26	4.43	4.08	4.12
P_2O_5	.30	.26	.33	.20	.20	.27	.20	.24	.24
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.08	1.06	1.08	.82	.88	.90	.87	1.05	.99
TOTAL	98.09	100.07	99.74	99.82	100.12	98.81	99.94	99.74	100.28
Fe_2O_3t	1.54	1.52	1.51	1.81	1.43	1.84	1.43	1.44	1.62
A/CNK	1.2	1.3	1.1	1.2	1.2	1.2	1.2	1.2	1.2
DI	89.8	92.5	92.4	92.9	92.8	91.3	92.6	92.6	93.0
Ba	270.	43.	286.	52.	82.	72.	53.	5.	6.
Rb	214.	464.	215.	384.	328.	353.	342.	431.	413.
Sr	55.	24.	57.	23.	26.	34.	39.	7.	7.
Y	8.	3.	9.	13.	13.	7.	10.	7.	7.
Zr	59.	43.	59.	52.	48.	53.	46.	41.	38.
Nb	11.	15.	12.	13.	9.	10.	9.	12.	13.
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	17.0	7.0	9.0	23.0	8.0	25.0	10.0	-	-
Cu	5.0	8.0	5.0	2.0	3.0	7.0	-	1.0	3.0
Ni	3.0	3.0	2.0	1.0	1.0	1.0	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	13.	9.	13.	10.	9.	11.	9.	7.	9.
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	2.	1.	1.	2.	1.	2.	2.	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	6.0	-	6.0	7.0	9.0	5.0	8.0	14.0	12.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NTS832 HALI ALAS	NTS833 HALI ALAS	NTS834 HALI ALAS	NTS835 HALI ALAS	NTS836 HALI MONG	NTS837 HALI MONG	NTS838 HALI ALAS	NTS839 HALI ALAS	NTS840 HALI MONG
SiO_2	74.54	75.54	74.81	75.58	74.90	76.60	75.67	75.43	74.69
TiO_2	.11	.12	.11	.10	.17	.12	.11	.13	.23
Al_2O_3	13.56	13.70	13.58	14.02	13.09	13.70	13.31	12.95	13.57
Fe_2O_3	1.25	1.31	1.33	1.03	1.78	1.57	1.21	1.40	1.94
FeO	-	-	-	-	-	-	-	-	-
MnO	.05	.05	.04	.03	.06	.04	.05	.04	.05
MgO	.25	.06	.02	.03	.14	.06	.13	.08	.33
CaO	.44	.42	.40	.42	.78	.39	.40	.40	.58
Na_2O	3.40	3.45	3.58	3.60	3.14	3.48	3.62	3.53	3.54
K_2O	4.13	4.17	4.32	3.79	4.22	4.32	4.53	4.76	4.35
P_2O_5	.23	.21	.22	.20	.20	.22	.18	.14	.24
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.01	1.01	1.10	1.20	1.08	1.13	.91	.83	1.11
TOTAL	98.97	100.04	99.51	100.00	99.56	101.63	100.12	99.69	100.63
Fe_2O_3t	1.25	1.31	1.33	1.03	1.78	1.57	1.21	1.40	1.94
A/CNK	1.3	1.3	1.2	1.3	1.2	1.2	1.2	1.1	1.2
DI	91.5	92.9	93.0	92.6	90.7	94.5	94.1	94.1	92.0
Ba	3.	8.	6.	-	58.	34.	2.	10.	116.
Rb	424.	417.	417.	405.	320.	324.	311.	279.	327.
Sr	7.	8.	7.	5.	23.	12.	8.	15.	38.
Y	7.	7.	5.	3.	14.	14.	10.	14.	15.
Zr	37.	36.	32.	29.	59.	48.	33.	36.	80.
Nb	10.	11.	11.	8.	12.	12.	9.	9.	13.
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	11.0	12.0	-	-	28.0	-	-	16.0	13.0
Cu	9.0	1.0	13.0	12.0	3.0	6.0	2.0	33.0	2.0
Ni	3.0	-	2.0	-	-	3.0	-	-	2.0
TiO_2	-	-	-	-	-	-	-	-	-
V	6.	6.	9.	6.	12.	7.	6.	7.	19.
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	2.	-	3.	-	3.	2.	2.	-	2.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	12.0	12.0	10.0	9.0	9.0	7.0	9.0	7.0	7.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

NOVA SCOTIA

	NWG627 WEST MONG	NWG636 WEST MONG	NWG771 WEST MONG	NWG779 WEST MONG
SiO_2	73.20	70.95	73.30	74.05
TiO_2	.28	.43	.22	.17
Al_2O_3	15.12	15.20	15.09	14.85
Fe_2O_3	1.65	2.86	1.21	1.30
FeO	-	-	-	-
MnO	.04	.05	.03	.04
MgO	.51	.85	.36	.29
CaO	.43	1.29	.60	.55
Na_2O	3.10	3.63	3.76	3.37
K_2O	4.72	3.77	4.53	4.60
P_2O_5	.27	.31	.30	.16
H_2O+	-	-	-	-
H_2O-	-	-	-	-
CO_2	-	-	-	-
Cl	-	-	-	-
F	-	-	-	-
LOI	.82	.61	.66	.61
TOTAL	100.14	99.95	100.06	99.99
Fe_2O_3t	1.65	2.86	1.21	1.30
A/CNK	1.4	1.2	1.2	1.3
DI	90.3	85.2	91.7	91.4
Ba	347.	693.	596.	768.
Rb	297.	118.	157.	178.
Sr	67.	146.	92.	84.
Y	13.	19.	11.	23.
Zr	119.	168.	79.	73.
Nb	12.	12.	9.	11.
Th	4.00	5.00	5.50	4.00
Pb	22.	26.	30.	27.
Ga	20.	21.	18.	17.
Zn	54.0	58.0	58.0	48.0
Cu	-	-	-	-
Ni	5.0	7.0	3.0	5.0
TiO_2	-	-	-	-
V	17.	23.	6.	4.
Cr	28.	28.	33.	26.
Hf	-	-	-	-
Cs	-	-	-	-
Sc	-	-	-	-
Ta	-	-	-	-
Co	-	-	-	-
Li	125.0	33.0	55.0	30.0
Be	4.0	-	3.0	-
B	-	-	-	-
F	560.	310.	210.	360.
Cl	-	-	-	-
U	4.00	3.80	5.00	3.60
W	-	-	-	-
Sn	29.0	11.0	5.0	9.0
Mo	-	-	-	-
La	-	-	-	-
Ce	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAG11 ZAER GRAD	MAG12 ZAER TONA	MAG13 ZAER GRAD	MAG15 ZAER GRAD	MAG18 ZAER GRAD	MAG2 ZAER MONG	MAG20 ZAER GRAD	MAG21 ZAER GRAD	MAG22 ZAER GRAD
SiO_2	65.10	66.70	68.30	70.40	66.70	67.20	67.30	67.00	72.50
TiO_2	.50	.40	.40	.40	.50	.65	.45	.55	.20
Al_2O_3	16.70	17.50	16.40	14.90	16.50	16.50	16.90	15.90	14.10
Fe_2O_3	3.90	2.93	2.90	1.73	2.11	1.55	2.73	3.34	1.33
FeO	–	.15	–	.65	1.88	2.17	.15	.14	.15
MnO	.07	.06	.05	.05	.05	.05	.05	.05	.03
MgO	1.50	1.10	.90	1.00	1.90	1.90	1.00	1.35	.55
CaO	2.30	1.99	1.30	1.35	2.60	2.90	1.40	1.85	.70
Na_2O	3.50	3.70	3.50	3.00	3.65	3.40	2.70	3.00	3.20
K_2O	3.60	3.40	3.70	4.75	3.25	2.80	4.30	4.00	4.80
P_2O_5	–	–	–	–	–	–	–	–	–
H_2O+	2.22	1.96	2.36	1.05	1.03	.84	.43	1.86	1.55
H_2O-	.55	.74	.40	.24	.03	–	.72	.49	.85
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.94	100.63	100.21	99.52	100.20	99.96	98.13	99.53	99.96
Fe_2O_3t	3.90	3.10	2.90	2.45	4.20	3.96	2.90	3.50	1.50
A/CNK	1.2	1.3	1.4	1.2	1.2	1.2	1.5	1.3	1.2
DI	76.8	79.8	83.4	84.9	75.1	72.8	79.8	79.2	90.8
Ba	460.	310.	420.	458.	285.	540.	358.	402.	330.
Rb	120.	192.	150.	260.	109.	121.	241.	222.	303.
Sr	280.	325.	175.	250.	340.	290.	245.	260.	150.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	34.0	–	30.0	34.0	45.0	36.0	28.0	22.0
Cu	–	2.0	–	6.0	10.0	13.0	4.0	7.0	7.0
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	50.0	58.0	90.0	85.0	44.0	45.0	59.0	57.0	97.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	10.0	–	10.0	10.0	10.0	10.0	10.0	10.0
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAG23 ZAER GRAD	MAG24 ZAER GRAD	MAG27 ZAER GRAD	MAG28 ZAER GRAD	MAG34 ZAER MONG	MAG35 ZAER GRAD	MAG36 ZAER GRAD	MAG39 ZAER MONG	MAG40 ZAER MONG
SiO_2	70.30	66.10	71.50	66.88	64.70	69.20	69.50	70.35	70.80
TiO_2	.35	.45	.15	.36	.55	.45	.20	.25	.15
Al_2O_3	15.20	16.10	15.30	17.15	17.20	16.80	16.10	16.05	16.70
Fe_2O_3	2.42	3.80	1.73	2.76	3.44	2.64	2.10	1.46	1.97
FeO	.07	–	.15	.14	.14	.14	–	.22	.07
MnO	.04	.05	.03	.02	.04	.03	.03	.02	.01
MgO	.95	1.30	.54	1.10	1.55	1.20	.60	.40	.34
CaO	1.05	2.50	.48	1.40	1.80	1.60	1.30	.45	.25
Na_2O	3.20	3.80	1.90	1.36	2.60	2.10	2.90	3.00	1.80
K_2O	4.30	3.30	4.40	5.80	3.90	3.80	4.50	5.00	4.80
P_2O_5	–	–	–	–	–	–	–	–	–
H_2O+	1.71	1.72	2.60	.78	2.65	2.34	2.02	2.25	2.91
H_2O-	.18	.39	.57	.20	.56	.48	.34	.30	.46
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.77	99.51	99.35	97.95	99.13	100.78	99.59	99.75	100.26
Fe_2O_3t	2.50	3.80	1.90	2.92	3.60	2.80	2.10	1.70	2.05
A/CNK	1.3	1.1	1.8	1.6	1.5	1.6	1.3	1.4	1.9
DI	85.7	77.4	86.6	78.7	76.0	79.7	84.9	89.4	87.5
Ba	345.	415.	235.	235.	345.	338.	445.	225.	150.
Rb	274.	115.	330.	314.	270.	262.	145.	452.	493.
Sr	215.	305.	140.	335.	290.	245.	220.	100.	100.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	34.0	–	33.0	35.0	57.0	20.0	–	37.0	71.0
Cu	5.0	–	60.0	9.0	15.0	5.0	–	3.0	2.0
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	89.0	45.0	99.0	66.0	77.0	39.0	60.0	103.0	54.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	11.0	–	11.0	11.0	13.0	10.0	–	20.0	21.0
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAG41 ZAER GRAD	MAG42 ZAER TONA	MAG43 ZAER MONG	MAG44 ZAER MONG	MAG45 ZAER MONG	MAG46 ZAER GRAD	MAG49 ZAER MONG	MAG5 ZAER TONA	MAG50 ZAER GRAD
SiO_2	71.80	67.30	71.60	71.90	73.00	72.00	75.00	66.20	73.50
TiO_2	.10	.50	.25	.10	.15	.15	.05	.50	.10
Al_2O_3	15.10	16.60	15.60	15.30	15.40	15.10	14.70	16.50	15.60
Fe_2O_3	1.13	1.55	1.29	1.13	1.29	1.37	.92	3.26	.80
FeO	.15	2.03	.14	.15	.14	.07	.07	.22	-
MnO	.02	.05	.02	.02	-	.01	-	.06	.03
MgO	.33	1.80	.33	.35	.30	.42	.21	1.40	.21
CaO	.47	2.55	.47	.65	.40	.58	.30	2.50	.50
Na_2O	2.80	3.55	3.10	3.10	2.90	2.80	3.10	3.60	3.00
K_2O	4.70	3.25	5.15	5.10	4.80	4.80	4.80	3.10	4.50
P_2O_5	-	-	-	-	-	-	-	-	-
H_2O+	1.95	.81	1.51	1.30	1.78	1.58	.99	1.47	1.34
H_2O-	.45	-	.16	.40	.20	.37	.05	.52	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.00	99.99	99.62	99.50	100.36	99.25	100.19	99.33	99.58
Fe_2O_3t	1.30	3.80	1.45	1.30	1.45	1.45	1.00	3.50	.80
A/CNK	1.4	1.2	1.4	1.3	1.4	1.4	1.4	1.2	1.5
DI	89.7	75.1	90.5	90.4	91.2	89.3	93.2	76.3	90.6
Ba	302.	405.	186.	100.	204.	136.	100.	330.	100.
Rb	543.	245.	398.	729.	560.	467.	582.	150.	528.
Sr	85.	358.	85.	65.	75.	65.	50.	315.	55.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	35.0	47.0	25.0	48.0	30.0	28.0	26.0	50.0	45.0
Cu	4.0	4.0	2.0	4.0	2.0	4.0	7.0	8.0	4.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	159.0	31.0	118.0	149.0	79.0	117.0	44.0	45.0	183.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	26.0	10.0	24.0	18.0	20.0	16.0	22.0	10.0	19.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAG51 ZAER GRAD	MAG52 ZAER GRAD	MAG53 ZAER MONG	MAG54 ZAER MONG	MAG55 ZAER MONG	MAG56 ZAER MONG	MAG57 ZAER GRAD	MAG58 ZAER MONG	MAG59 ZAER MONG
SiO_2	71.70	73.40	71.90	67.80	71.50	72.70	72.60	74.00	74.10
TiO_2	.05	.10	.15	.30	.20	.30	.30	.15	.02
Al_2O_3	15.65	16.30	15.20	18.30	15.65	15.30	15.80	14.50	15.40
Fe_2O_3	.73	1.10	1.13	1.65	1.50	1.95	1.75	.60	1.30
FeO	.15	-	.15	-	-	-	-	.36	-
MnO	.03	.02	.02	.02	.01	.02	.02	.03	.02
MgO	.23	.24	.28	.38	.26	.45	.40	.31	.23
CaO	.42	.40	.57	1.08	.30	.82	.43	.65	.40
Na_2O	3.00	2.70	3.55	3.20	2.00	3.10	2.30	3.50	2.35
K_2O	5.30	5.50	5.00	5.40	4.20	4.30	4.50	4.20	4.25
P_2O_5	-	-	-	-	-	-	-	-	-
H_2O+	1.55	1.47	1.47	2.04	3.00	1.41	1.93	1.28	1.38
H_2O-	.25	.09	.35	.39	.40	.23	.33	.09	.18
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.06	101.32	99.77	100.56	99.02	100.58	100.36	99.67	99.63
Fe_2O_3t	.90	1.10	1.30	1.65	1.50	1.95	1.75	1.00	1.30
A/CNK	1.4	1.5	1.2	1.4	1.9	1.4	1.7	1.3	1.7
DI	91.1	92.2	91.7	86.7	87.5	88.9	88.5	91.4	89.4
Ba	100.	100.	170.	350.	100.	235.	214.	204.	100.
Rb	729.	513.	480.	458.	443.	425.	570.	455.	580.
Sr	65.	70.	65.	120.	50.	85.	60.	75.	30.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	1.0	37.0	47.0	46.0	37.0	56.0	54.0	55.0	52.0
Cu	3.0	2.0	1.0	2.0	2.0	1.0	9.0	2.0	1.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	149.0	150.0	128.0	56.0	126.0	131.0	142.0	167.0	162.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	28.0
Sn	23.0	17.0	15.0	10.0	14.0	18.0	18.0	25.0	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAG60 ZAER GRAD	MAG61 ZAER GRAD	MAG62 ZAER MONG	MAG63 ZAER MONG	MAG64 ZAER MONG	MAG65 ZAER MONG	MAG66 ZAER MONG	MAG67 ZAER MONG	MAG68 ZAER GRAD
SiO_2	65.00	66.40	70.90	71.70	74.10	70.80	70.60	72.30	-
TiO_2	.70	.55	.35	.25	.25	.35	.20	.10	-
Al_2O_3	16.70	15.70	15.70	15.60	14.80	15.10	15.10	15.30	-
Fe_2O_3	4.43	4.30	1.85	1.30	1.50	1.90	1.55	1.25	-
FeO	.15	-	-	-	-	-	-	-	-
MnO	.07	.05	.02	.01	.02	.04	.01	-	-
MgO	1.80	1.60	.50	.25	.30	.46	.51	.30	-
CaO	.29	2.35	.70	.43	.51	1.05	.51	.68	-
Na_2O	3.80	3.30	2.40	2.90	2.70	3.20	1.80	3.40	-
K_2O	3.00	3.80	4.30	5.20	4.40	4.20	6.30	4.40	-
P_2O_5	-	-	-	-	-	-	-	-	-
H_2O+	1.92	1.97	2.10	1.38	1.40	2.42	1.85	1.39	-
H_2O-	.78	.46	.58	.21	.12	.39	.83	.41	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	98.64	100.48	99.40	99.23	100.10	99.91	99.26	99.53	-
Fe_2O_3t	4.60	4.30	1.85	1.30	1.50	1.90	1.55	1.25	.00
A/CNK	1.7	1.1	1.6	1.4	1.5	1.3	1.4	1.3	-
DI	80.2	77.5	86.3	90.4	90.2	87.5	89.0	90.2	-
Ba	475.	675.	305.	337.	355.	345.	225.	240.	175.
Rb	108.	120.	414.	350.	462.	370.	330.	344.	230.
Sr	340.	325.	90.	75.	90.	105.	75.	50.	85.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	92.0	-	52.0	32.0	45.0	56.0	-	45.0	55.0
Cu	9.0	-	7.0	3.0	4.0	3.0	-	2.0	2.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	65.0	60.0	71.0	65.0	100.0	128.0	85.0	56.0	40.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	10.0	-	13.0	12.0	12.0	17.0	-	13.0	10.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAG69 ZAER MONG	MAG70 ZAER MONG	MAG71 ZAER MONG	MAG72 ZAER MONG	MAG73 ZAER MONG	MAG74 ZAER MONG	MAG75 ZAER TONA	MAG76 ZAER GRAD	MAG77 ZAER MONG
SiO_2	71.70	68.70	73.20	71.60	75.60	71.70	63.60	75.20	70.50
TiO_2	.15	.04	.10	.30	.10	.15	.80	.05	.15
Al_2O_3	15.00	16.00	14.90	15.50	13.70	15.20	17.90	15.10	16.50
Fe_2O_3	1.23	2.48	1.25	1.50	.83	1.65	1.30	.75	1.60
FeO	.15	.15	-	-	.15	-	3.33	-	-
MnO	.01	.04	-	.02	-	-	.03	.03	.02
MgO	.35	.75	.27	.37	.25	.31	2.00	.12	.37
CaO	.70	1.70	.15	.53	.35	.43	3.15	.40	.52
Na_2O	2.60	3.30	2.50	2.60	2.60	2.60	3.70	3.60	2.40
K_2O	4.90	3.80	4.85	5.20	4.80	4.60	3.70	4.00	4.70
P_2O_5	-	-	-	-	-	-	-	-	-
H_2O+	1.71	1.65	1.81	1.53	1.31	1.88	.88	1.17	1.91
H_2O-	.71	.48	.45	.49	.25	.41	.17	.13	.38
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.21	99.09	99.48	99.64	99.94	98.93	100.56	100.55	99.05
Fe_2O_3t	1.40	2.65	1.25	1.50	1.00	1.65	5.00	.75	1.60
A/CNK	1.4	1.3	1.6	1.4	1.4	1.5	1.1	1.4	1.7
DI	88.9	82.4	91.3	89.4	92.8	88.8	70.4	93.2	87.0
Ba	174.	430.	232.	298.	134.	100.	775.	100.	265.
Rb	422.	368.	486.	314.	300.	340.	110.	380.	288.
Sr	90.	170.	55.	75.	95.	50.	520.	-	65.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	16.0	52.0	14.0	57.0	27.0	68.0	-	19.0	61.0
Cu	9.0	6.0	2.0	1.0	4.0	2.0	-	1.0	4.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	58.0	118.0	54.0	58.0	142.0	52.0	95.0	77.0	136.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	18.0	12.0	16.0	10.0	18.0	16.0	-	25.0	12.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAG78 ZAER GRAD	MAG79 ZAER MONG	MAG80 ZAER MONG	MAG81 ZAER GRAD	MAG82 ZAER MONG	MAG83 ZAER MONG	MAG84 ZAER GRAD	MAG85 ZAER TONA	MAG86 ZAER QUAD
SiO_2	72.30	71.50	72.40	71.90	71.40	73.10	74.40	62.70	66.80
TiO_2	.10	.30	.10	.10	.05	.10	.05	.75	.65
Al_2O_3	15.50	15.60	15.50	15.50	15.80	15.15	14.70	16.70	15.90
Fe_2O_3	.73	1.80	.75	.73	.73	.10	.85	2.28	2.39
FeO	.15	-	-	.15	.29	-	-	2.90	1.81
MnO	-	-	-	-	.01	.01	-	.07	.06
MgO	.23	.47	.19	.25	.25	.23	.05	2.50	1.90
CaO	.82	.85	.92	.50	.65	.45	-	3.60	2.80
Na_2O	2.90	2.70	3.30	2.75	3.50	2.75	.20	3.90	3.90
K_2O	4.90	5.00	4.75	5.55	4.75	5.70	4.50	2.80	2.95
P_2O_5	-	1.40	-	-	-	-	-	-	-
H_2O+	1.68	.46	.98	1.45	1.26	1.24	1.13	1.34	1.19
H_2O-	.37	-	.16	.25	.39	.27	.22	.16	.39
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.68	100.08	99.05	99.13	99.08	99.10	96.10	99.70	100.74
Fe_2O_3t	.90	1.80	.75	.90	1.05	.10	.85	5.50	4.40
A/CNK	1.3	1.4	1.3	1.4	1.3	1.3	2.8	1.0	1.1
DI	89.9	88.8	89.8	90.8	90.3	92.3	85.4	67.4	75.4
Ba	200.	525.	205.	335.	100.	225.	100.	635.	495.
Rb	408.	463.	463.	472.	516.	580.	570.	105.	105.
Sr	50.	100.	75.	78.	90.	35.	25.	460.	345.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	12.0	73.0	22.0	30.0	40.0	40.0	35.0	-	-
Cu	1.0	1.0	2.0	1.0	12.0	11.0	6.0	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	56.0	48.0	53.0	42.0	140.0	78.0	195.0	60.0	55.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	12.0	13.0	13.0	16.0	23.0	21.0	42.0	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAG87 ZAER TONA	MAG89 ZAER TONA	MAG90 ZAER MONG	MAG91 ZAER MONG	MAG92 ZAER GRAD	MAG94 ZAER GRAD	MAG95 ZAER TONA	MAG96 ZAER MONG	MAG97 ZAER MONG
SiO_2	69.20	66.40	72.50	75.30	-	67.90	65.80	-	72.60
TiO_2	.45	.60	.05	.15	-	.55	.60	-	.10
Al_2O_3	15.40	15.60	14.80	14.30	-	15.60	16.80	-	15.30
Fe_2O_3	1.09	2.25	.93	.95	-	2.10	1.42	-	1.00
FeO	2.17	1.89	.29	-	-	1.17	2.32	-	-
MnO	.06	.06	.02	.03	-	.05	.06	-	.03
MgO	1.60	2.00	.30	.19	-	1.70	2.00	-	.21
CaO	3.15	2.80	.55	.60	-	2.65	3.15	-	.72
Na_2O	4.00	3.50	2.40	3.30	-	3.70	3.75	-	3.00
K_2O	2.45	3.00	6.50	4.50	-	3.25	2.90	-	5.00
P_2O_5	-	-	-	-	-	-	-	-	-
H_2O+	.86	.98	1.17	.88	-	1.29	.65	-	.97
H_2O-	.14	.29	.17	.06	-	.33	.10	-	.11
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.57	99.37	99.68	100.26	-	100.29	99.55	-	99.04
Fe_2O_3t	3.50	4.35	1.25	.95	.00	3.40	4.00	.00	1.00
A/CNK	1.0	1.1	1.2	1.3	-	1.1	1.1	-	1.3
DI	75.4	73.5	92.0	92.7	-	77.5	71.6	-	90.1
Ba	490.	850.	175.	176.	1000.	542.	735.	855.	100.
Rb	100.	112.	430.	532.	150.	149.	100.	255.	275.
Sr	395.	270.	95.	35.	225.	315.	270.	175.	55.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	60.0	54.0	41.0	100.0	62.0	60.0	-	-
Cu	-	11.0	9.0	3.0	12.0	8.0	2.0	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	65.0	65.0	175.0	155.0	50.0	63.0	78.0	100.0	90.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	13.0	25.0	21.0	10.0	13.0	13.0	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAL1 OULM MONG	MAL11 OULM MONG	MAL12 OULM MONG	MAL13 OULM MONG	MAL2 OULM MONG	MAL3 OULM MONG	MAL5 OULM MONG	MAL6 OULM MONG	MAL7 OULM MONG.
SiO_2	71.80	73.20	-	-	72.60	73.00	72.40	73.00	74.00
TiO_2	.10	.10	-	-	.05	.05	.15	.15	.15
Al_2O_3	16.10	15.20	-	-	15.80	15.70	15.60	15.20	14.50
Fe_2O_3	.95	.61	-	-	.58	.42	.53	.88	.72
FeO	-	.22	-	-	.29	.43	.51	.29	.43
MnO	.02	.08	-	-	.04	.06	.03	.04	.05
MgO	.20	.08	-	-	.18	.13	.30	.25	.20
CaO	.95	.35	-	-	.70	.40	.60	.45	.50
Na_2O	3.70	4.80	-	-	3.70	3.90	3.20	3.10	4.05
K_2O	5.05	4.05	-	-	4.45	4.45	5.65	5.65	4.85
P_2O_5	-	-	-	-	-	-	-	-	-
H_2O+	1.05	.80	-	-	1.54	1.68	1.30	1.41	.95
H_2O-	.20	.10	-	-	.14	.08	.06	.25	.10
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.12	99.59	-	-	100.07	100.30	100.33	100.67	100.50
Fe_2O_3t	.95	.85	.00	.00	.90	.90	1.10	1.20	1.20
A/CNK	1.2	1.2	-	-	1.3	1.3	1.3	1.3	1.1
DI	90.9	94.3	-	-	91.4	93.0	92.0	93.2	94.4
Ba	185.	-	249.	7.	-	-	240.	135.	120.
Rb	260.	510.	369.	723.	250.	535.	335.	270.	410.
Sr	100.	-	76.	19.	90.	35.	75.	70.	40.
Y	-	-	10.	8.	-	-	-	-	-
Zr	-	-	75.	32.	-	-	-	-	-
Nb	-	-	10.	17.	-	-	-	-	-
Th	-	-	13.00	3.00	-	-	-	-	-
Pb	-	-	34.	19.	-	-	-	-	-
Ga	-	-	19.	23.	-	-	-	-	-
Zn	-	-	67.0	68.0	-	-	-	-	-
Cu	-	-	1.0	-	-	-	-	-	-
Ni	-	-	6.0	10.0	-	-	-	-	-
TiO_2	-	-	.16	.01	-	-	-	-	-
V	-	-	5.	1.	-	-	-	-	-
Cr	-	-	12.	10.	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	190.0	250.0	-	-	365.0	670.0	415.0	225.0	255.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAL7A OULM MONG	MAL8A OULM MONG	MAM106 ZAER GRAD	MAM109 ZAER MONG	MAM266 ZAER GRAD	MAM267 ZAER MONG	MAM268 ZAER GRAD	MAM281 ZAER TONA	MAM283 ZAER GRAD
SiO_2	75.20	75.40	73.80	73.70	67.80	68.10	67.80	67.30	67.30
TiO_2	.15	.10	.10	.10	.60	.50	.50	.50	.55
Al_2O_3	13.30	14.60	15.50	14.50	15.60	16.10	15.70	16.00	15.60
Fe_2O_3	.50	.62	.29	.78	1.42	.96	1.02	.94	1.22
FeO	-	.43	.37	.29	2.05	2.20	2.05	2.35	2.05
MnO	.01	.01	.02	.02	.05	.05	.05	.06	.05
MgO	.07	.20	.10	.29	1.70	1.60	1.60	1.70	1.60
CaO	.30	.65	.14	.68	2.40	2.80	2.45	2.60	2.55
Na_2O	3.20	3.00	3.70	3.30	3.60	4.20	3.85	3.90	3.75
K_2O	5.75	4.85	3.80	4.30	3.10	3.20	3.30	3.10	3.35
P_2O_5	-	-	1.21	-	-	-	-	-	-
H_2O+	1.04	1.00	.17	1.09	1.14	.39	.79	.42	.93
H_2O-	.11	.10	-	.13	.30	.10	.20	.17	.20
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.63	100.96	99.20	99.18	99.76	100.20	99.31	99.04	99.15
Fe_2O_3t	.50	1.10	.70	1.10	3.70	3.40	3.30	3.55	3.50
A/CNK	1.1	1.3	1.5	1.3	1.1	1.0	1.1	1.1	1.1
DI	96.0	92.7	91.4	90.6	76.4	76.7	77.0	75.1	76.3
Ba	115.	200.	100.	100.	535.	480.	515.	495.	585.
Rb	390.	290.	715.	390.	120.	115.	120.	110.	100.
Sr	35.	80.	25.	40.	320.	340.	335.	330.	340.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	100.0	60.0	55.0	50.0	55.0	50.0	70.0
Cu	-	-	-	-	5.0	-	-	-	10.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	255.0	250.0	420.0	225.0	80.0	70.0	95.0	70.0	65.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	65.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAM289 ZAER GRAD	MAM291 ZAER GRAN	MAM293 ZAER TONA	MAM294 ZAER MONG	MAM295 ZAER GRAN	MAM303 ZAER MONG	MAM320 ZAER GRAN	MAM322 ZAER MONG	MAM324 ZAER GRAN
SiO_2	73.30	73.80	62.90	74.00	68.40	72.60	–	72.80	–
TiO_2	.15	.10	.80	–	.55	.05	–	.15	–
Al_2O_3	14.60	14.80	17.10	14.20	15.80	16.10	–	15.00	–
Fe_2O_3	1.20	.93	1.49	1.10	1.06	.33	–	.62	–
FeO	.80	.15	4.56	–	2.20	.15	–	.43	–
MnO	.03	.04	.07	.04	.05	–	–	–	–
MgO	.40	.22	2.60	.15	1.60	.25	–	.24	–
CaO	1.40	.50	4.00	.50	2.50	.25	–	1.00	–
Na_2O	3.90	3.40	3.40	3.50	3.80	3.70	–	3.30	–
K_2O	4.00	4.40	3.00	4.80	3.10	5.20	–	4.90	–
P_2O_5	–	–	–	–	–	–	–	–	–
H_2O+	1.00	.97	.71	1.12	.55	1.34	–	.77	–
H_2O-	.20	.24	–	.16	.13	.12	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	100.98	99.55	100.63	99.57	99.74	100.09	–	99.21	–
Fe_2O_3t	2.09	1.10	6.55	1.10	3.50	.50	.00	1.10	.00
A/CNK	1.1	1.3	1.1	1.2	1.1	1.3	–	1.2	–
DI	89.3	91.7	63.4	93.2	76.6	93.7	–	89.9	–
Ba	705.	100.	515.	170.	100.	100.	515.	200.	228.
Rb	125.	215.	105.	200.	110.	350.	112.	270.	138.
Sr	205.	45.	345.	40.	325.	55.	416.	65.	264.
Y	–	–	–	–	–	–	18.	–	26.
Zr	–	–	–	–	–	–	166.	–	199.
Nb	–	–	–	–	–	–	14.	–	16.
Th	–	–	–	–	–	–	2.00	–	9.00
Pb	–	–	–	–	–	–	14.	–	21.
Ga	–	–	–	–	–	–	22.	–	23.
Zn	–	40.0	70.0	–	50.0	30.0	70.0	50.0	57.0
Cu	–	–	5.0	–	5.0	–	14.0	–	1.0
Ni	–	–	–	–	–	–	34.0	–	22.0
TiO_2	–	–	–	–	–	–	.95	–	.79
V	–	–	–	–	–	–	101.	–	81.
Cr	–	–	–	–	–	–	61.	–	54.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	55.0	35.0	80.0	35.0	80.0	60.0	–	110.0	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAM325 ZAER GRAD	MAM326 ZAER GRAD	MAM329 ZAER TONA	MAM330 ZAER GRAD	MAM332 ZAER MONG	MAM336 ZAER GRAD	MAM337 ZAER GRAN	MAM352 ZAER GRAN	MAM353 ZAER GRAN
SiO_2	72.80	73.60	66.50	69.50	71.50	73.30	73.20	-	-
TiO_2	.20	.05	.70	.45	.30	.05	.05	-	-
Al_2O_3	15.60	15.50	16.50	16.20	15.50	14.30	15.80	-	-
Fe_2O_3	1.07	.75	1.37	1.04	1.16	.96	.86	-	-
FeO	.43	-	2.82	1.59	.94	.22	.22	-	-
MnO	.01	.01	.07	.06	.04	-	.05	-	-
MgO	.25	.20	2.10	1.10	.80	.18	.08	-	-
CaO	.95	.67	3.10	2.00	1.55	.37	.37	-	-
Na_2O	3.20	3.60	3.70	3.90	3.70	2.90	3.70	-	-
K_2O	5.40	5.40	3.10	3.50	4.30	4.75	3.90	-	-
P_2O_5	-	-	-	-	-	-	-	-	-
H_2O+	.54	.70	.41	.47	.58	1.06	1.25	-	-
H_2O-	.13	.05	.12	.05	.12	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.58	100.53	100.49	99.86	100.49	98.09	99.48	-	-
Fe_2O_3t	1.55	.75	4.50	2.80	2.20	1.20	1.10	.00	.00
A/CNK	1.2	1.2	1.1	1.2	1.1	1.4	1.4	-	-
DI	90.7	93.3	72.0	80.9	86.2	90.8	91.3	-	-
Ba	355.	175.	276.	495.	400.	100.	100.	599.	529.
Rb	355.	200.	57.	140.	170.	445.	900.	115.	135.
Sr	110.	105.	680.	275.	220.	20.	55.	336.	265.
Y	-	-	20.	-	-	-	-	25.	23.
Zr	-	-	101.	-	-	-	-	154.	139.
Nb	-	-	7.	-	-	-	-	12.	13.
Th	-	-	2.00	-	-	-	-	9.00	11.00
Pb	-	-	6.	-	-	-	-	20.	22.
Ga	-	-	17.	-	-	-	-	22.	20.
Zn	65.0	15.0	85.0	-	35.0	115.0	90.0	47.0	40.0
Cu	-	-	36.0	-	-	-	-	4.0	-
Ni	-	-	94.0	-	-	-	-	18.0	12.0
TiO_2	-	-	.97	-	-	-	-	.63	.48
V	-	-	154.	-	-	-	-	61.	42.
Cr	-	-	265.	-	-	-	-	61.	31.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	115.0	200.0	-	85.0	120.0	165.0	450.0	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAM354 ZAER GRAN	MAM355 ZAER GRAN	MAM356 ZAER GRAN	MAM357 ZAER GRAN	MAM358 ZAER GRAN	MAM360 ZAER GRAN	MAM361 ZAER GRAN	MAM362 ZAER GRAN	MAM363 ZAER GRAN
SiO_2	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
Al_2O_3	-	-	-	-	-	-	-	-	-
Fe_2O_3	-	-	-	-	-	-	-	-	-
FeO	-	-	-	-	-	-	-	-	-
MnO	-	-	-	-	-	-	-	-	-
MgO	-	-	-	-	-	-	-	-	-
CaO	-	-	-	-	-	-	-	-	-
Na_2O	-	-	-	-	-	-	-	-	-
K_2O	-	-	-	-	-	-	-	-	-
P_2O_5	-	-	-	-	-	-	-	-	-
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-
Fe_2O_3t	.00	.00	.00	.00	.00	.00	.00	.00	.00
A/CNK	-	-	-	-	-	-	-	-	-
DI	-	-	-	-	-	-	-	-	-
Ba	151.	183.	176.	600.	799.	32.	61.	41.	425.
Rb	384.	361.	359.	103.	90.	865.	543.	650.	249.
Sr	48.	49.	50.	391.	451.	22.	11.	14.	113.
Y	14.	12.	11.	23.	18.	22.	20.	21.	37.
Zr	55.	57.	46.	175.	193.	48.	48.	49.	237.
Nb	12.	11.	9.	12.	13.	36.	23.	20.	15.
Th	8.00	7.00	6.00	7.00	4.00	19.00	38.00	30.00	19.00
Pb	27.	26.	24.	17.	16.	24.	23.	29.	25.
Ga	24.	23.	21.	22.	24.	33.	27.	26.	20.
Zn	68.0	71.0	43.0	57.0	57.0	37.0	51.0	80.0	71.0
Cu	14.0	26.0	-	1.0	11.0	13.0	112.0	31.0	-
Ni	4.0	6.0	5.0	24.0	24.0	16.0	11.0	13.0	13.0
TiO_2	.12	.11	.08	.76	.71	.07	.07	.08	.77
V	5.	2.	1.	76.	67.	3.	3.	1.	51.
Cr	11.	14.	14.	55.	52.	6.	11.	13.	23.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MAM364 ZAER GRAN	MAM365 ZAER GRAN	MAM366 ZAER GRAN	MAM5 ZAER GRAN	MAM84 ZAER GRAN	MAM9 ZAER GRAN	MBC13B ZAER GRAN	MBC15 ZAER GRAN	MBC18A ZAER GRAN
SiO_2	-	-	-	-	-	-	70.80	73.41	74.43
TiO_2	-	-	-	-	-	-	.38	.04	.13
Al_2O_3	-	-	-	-	-	-	14.58	15.68	14.40
Fe_2O_3	-	-	-	-	-	-	2.80	.90	1.11
FeO	-	-	-	-	-	-	-	-	-
MnO	-	-	-	-	-	-	.06	.05	.03
MgO	-	-	-	-	-	-	1.08	.01	.18
CaO	-	-	-	-	-	-	1.87	.37	.63
Na_2O	-	-	-	-	-	-	3.53	3.88	3.19
K_2O	-	-	-	-	-	-	3.73	3.87	4.81
P_2O_5	-	-	-	-	-	-	.13	.38	.19
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	.67	1.41	.93
TOTAL	-	-	-	-	-	-	99.63	100.00	100.03
Fe_2O_3t	.00	.00	.00	.00	.00	.00	2.80	.90	1.11
A/CNK	-	-	-	-	-	-	1.1	1.4	1.2
DI	-	-	-	-	-	-	82.7	91.7	91.8
Ba	373.	288.	837.	536.	625.	899.	648.	11.	181.
Rb	258.	251.	217.	173.	215.	173.	130.	752.	403.
Sr	85.	67.	87.	42.	90.	92.	261.	21.	45.
Y	49.	50.	51.	31.	36.	34.	23.	19.	16.
Zr	204.	221.	242.	149.	155.	200.	131.	34.	66.
Nb	14.	14.	17.	20.	20.	20.	14.	24.	15.
Th	24.00	27.00	22.00	13.00	20.00	14.00	13.00	8.00	9.00
Pb	30.	37.	34.	16.	24.	24.	22.	17.	21.
Ga	21.	20.	21.	33.	36.	31.	20.	29.	21.
Zn	39.0	87.0	61.0	40.0	87.0	106.0	33.0	91.0	73.0
Cu	-	-	-	53.0	20.0	51.0	2.0	-	1.0
Ni	10.0	10.0	7.0	44.0	42.0	28.0	17.0	48.0	28.0
TiO_2	.41	.35	.34	1.01	1.12	1.03	.53	.02	.15
V	25.	20.	11.	148.	175.	122.	47.	4.	8.
Cr	9.	10.	11.	137.	133.	106.	35.	13.	8.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MBC20A ZAER GRAN	MBC4 ZAER GRAN	MBRR11A TBAM MONG	MBRR12A TBAM MONG	MBRR14 TBAM MONG	MBRR16A TBAM MONG	MBRR18 TBAM MONG	MBRR22A TBAM MONG	MBRR7C TBAM MONG
SiO_2	–	67.83	70.26	71.06	70.64	70.93	70.58	67.83	70.57
TiO_2	–	.80	.50	.45	.48	.43	.49	.65	.52
Al_2O_3	–	14.44	14.85	14.70	14.69	14.28	14.69	15.58	14.54
Fe_2O_3	–	5.33	3.73	3.32	3.51	3.46	3.30	4.53	3.44
FeO	–	–	–	–	–	–	–	–	–
MnO	–	.10	.06	.05	.04	.06	.05	.07	.05
MgO	–	1.68	.86	.75	.69	.79	.75	1.26	.72
CaO	–	1.95	1.40	1.49	1.53	1.57	1.36	.88	1.75
Na_2O	–	3.65	2.52	2.65	2.72	2.59	2.73	2.51	2.81
K_2O	–	1.77	4.72	4.97	5.06	4.88	5.41	4.92	4.92
P_2O_5	–	.14	.11	.12	.13	.12	.11	.13	.12
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	2.22	.97	.72	.55	.70	.69	1.58	.40
TOTAL	–	99.91	99.98	100.28	100.04	99.81	100.16	99.94	99.84
Fe_2O_3t	.00	5.33	3.73	3.32	3.51	3.46	3.30	4.53	3.44
A/CNK	–	1.3	1.3	1.2	1.2	1.2	1.2	1.4	1.1
DI	–	74.9	82.8	84.4	84.4	83.7	85.3	81.3	83.8
Ba	213.	354.	403.	433.	390.	360.	580.	539.	470.
Rb	5.	54.	246.	248.	252.	259.	260.	230.	246.
Sr	564.	236.	93.	85.	84.	74.	78.	136.	77.
Y	29.	30.	46.	43.	46.	43.	44.	45.	45.
Zr	271.	208.	190.	177.	173.	168.	218.	229.	222.
Nb	37.	15.	12.	12.	12.	11.	12.	15.	12.
Th	1.00	7.00	25.00	19.00	20.00	22.00	27.00	19.00	23.00
Pb	2.	11.	23.	22.	21.	21.	21.	19.	20.
Ga	16.	17.	21.	18.	18.	19.	18.	21.	20.
Zn	50.0	75.0	54.0	43.0	40.0	38.0	39.0	70.0	40.0
Cu	47.0	10.0	7.0	3.0	9.0	7.0	6.0	5.0	4.0
Ni	46.0	23.0	32.0	32.0	31.0	28.0	29.0	29.0	32.0
TiO_2	2.58	.88	.55	.49	.44	.45	.53	.86	.55
V	209.	117.	69.	54.	46.	50.	53.	117.	66.
Cr	141.	91.	32.	29.	25.	27.	27.	50.	28.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MBRR8 TBAM MONG	MHU1 OUOU GRAD	MHU2 OUOU GRAD	MHU3 OUOU GRAD	MHU4 OUOU GRAD	MHU5 OUOU MONG	MJBL10 OUOU GRAD	MJBL12 OUOU GRAD	MJBL13 OUOU MONG
SiO_2	71.94	62.80	64.29	64.96	66.60	72.56	67.16	66.95	68.48
TiO_2	.45	.50	.88	.96	.63	.35	.73	.65	.59
Al_2O_3	14.37	16.55	14.57	16.12	14.79	13.45	15.83	16.13	15.56
Fe_2O_3	3.25	-	1.17	.46	.83	.92	4.93	4.31	4.08
FeO	-	4.32	4.88	4.70	3.73	1.29	-	-	-
MnO	.05	.06	.09	.10	.07	.03	.08	.07	.05
MgO	.69	2.25	2.28	2.34	1.65	.55	1.54	1.42	1.13
CaO	1.43	3.37	2.50	3.20	2.15	.84	1.88	2.38	1.57
Na_2O	2.66	2.58	2.70	1.80	3.08	2.53	2.84	3.18	2.74
K_2O	4.76	5.23	4.50	3.81	3.93	6.06	4.08	3.95	4.60
P_2O_5	.12	.30	.46	.22	.21	.10	.17	.16	.15
H_2O+	-	1.16	1.06	.96	1.59	1.16	-	-	-
H_2O-	-	.11	.51	.33	.14	.09	-	-	-
CO_2	-	.55	.15	.06	.57	.60	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.62	-	-	-	-	-	.78	.78	1.10
TOTAL	100.34	99.78	100.04	100.02	99.97	100.53	100.02	99.98	100.05
Fe_2O_3t	3.25	4.80	6.59	5.68	4.97	2.35	4.93	4.31	4.08
A/CNK	1.2	1.0	1.1	1.3	1.1	1.1	1.3	1.2	1.3
DI	85.1	68.8	71.5	65.7	75.8	90.7	77.3	76.8	80.7
Ba	368.	-	-	-	-	-	638.	629,	574.
Rb	249.	-	-	-	-	-	161.	156.	180.
Sr	76.	-	-	-	-	-	226.	326.	173.
Y	42.	-	-	-	-	-	32.	35.	34.
Zr	166.	-	-	-	-	-	216.	227.	212.
Nb	12.	-	-	-	-	-	15.	14.	15.
Th	21.00	-	-	-	-	-	15.00	18.00	18.00
Pb	18.	-	-	-	-	-	28.	27.	24.
Ga	19.	-	-	-	-	-	21.	19.	19.
Zn	40.0	-	-	-	-	-	68.0	62.0	48.0
Cu	6.0	-	-	-	-	-	17.0	17.0	8.0
Ni	31.0	-	-	-	-	-	30.0	26.0	28.0
TiO_2	.49	-	-	-	-	-	.79	.65	.65
V	52.	-	-	-	-	-	77.	69.	62.
Cr	31.	-	-	-	-	-	51.	46.	42.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MJBL1B OUOU APLI	MJBL21 OUOU GRAD	MJBL23 OUOU GRAD	MJBL24 OUOU GRAD	MJBL26 OUOU MONG	MJBL2A OUOU GRAD	MJBL3 OUOU MONG	MJBL6 OUOU GRAD	MJBL8 OUOU GRAD
SiO_2	75.66	66.21	68.12	66.20	69.46	66.41	68.98	66.18	–
TiO_2	.06	.74	.59	.64	.51	.71	.56	.76	–
Al_2O_3	13.66	16.18	15.67	16.10	15.08	16.08	15.52	16.37	–
Fe_2O_3	.42	5.26	4.10	4.59	3.66	4.92	3.98	5.32	–
FeO	–	–	–	–	–	–	–	–	–
MnO	.02	.08	.06	.07	.05	.08	.05	.08	–
MgO	.06	1.45	1.34	1.71	.97	1.47	.99	1.55	–
CaO	.37	2.46	2.16	2.17	1.70	2.30	1.48	1.99	–
Na_2O	2.99	2.94	3.14	3.22	2.93	2.88	2.53	2.69	–
K_2O	5.73	3.78	4.09	4.10	4.54	3.90	4.71	4.14	–
P_2O_5	.12	.18	.17	.14	.14	.18	.20	.18	–
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	.62	.81	.84	1.19	1.08	.86	1.11	1.07	–
TOTAL	99.71	100.09	100.28	100.13	100.12	99.79	100.11	100.33	–
Fe_2O_3t	.42	5.26	4.10	4.59	3.66	4.92	3.98	5.32	.00
A/CNK	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	–
DI	95.0	74.9	78.8	76.4	82.0	75.5	81.4	75.8	–
Ba	217.	537.	622.	553.	508.	611.	640.	589.	565.
Rb	286.	153.	158.	151.	180.	160.	183.	168.	149.
Sr	94.	231.	321.	277.	157.	248.	158.	217.	223.
Y	17.	36.	30.	29.	35.	37.	35.	33.	35.
Zr	40.	229.	179.	190.	186.	230.	209.	231.	238.
Nb	6.	15.	14.	14.	15.	16.	16.	16.	17.
Th	3.00	14.00	15.00	11.00	20.00	13.00	13.00	17.00	13.00
Pb	49.	23.	22.	18.	24.	25.	72.	26.	25.
Ga	15.	21.	18.	21.	18.	19.	21.	18.	20.
Zn	15.0	79.0	56.0	60.0	38.0	63.0	157.0	74.0	68.0
Cu	–	20.0	18.0	12.0	7.0	9.0	14.0	18.0	23.0
Ni	20.0	29.0	27.0	26.0	21.0	24.0	29.0	27.0	27.0
TiO_2	.05	.79	.59	.81	.58	.78	.65	.88	.76
V	1.	85.	60.	93.	55.	82.	62.	91.	83.
Cr	10.	50.	40.	60.	35.	53.	34.	59.	53.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MJUB18 OUOU MONG	MJUB19 OUOU MONG	MJUB21 OUOU MONG	MJUB24 OUOU MONG	MJUB4 OUOU MONG	MJUB6 OUOU GRAD	MJUB9 OUOU GRAD	MME1 MENT MONG	MME10 MENT MONG
SiO_2	67.03	67.12	67.69	66.57	66.18	68.57	67.84	71.80	76.60
TiO_2	.63	.67	.52	.60	.71	.48	.64	.40	–
Al_2O_3	15.74	15.80	15.58	15.80	16.11	15.75	15.63	13.80	13.70
Fe_2O_3	4.36	4.82	3.79	4.14	4.97	3.21	4.37	1.89	.90
FeO	–	–	–	–	–	–	–	1.09	.36
MnO	.07	.10	.07	.06	.08	.05	.07	.05	.03
MgO	1.44	1.30	1.12	1.46	1.46	1.01	1.41	.55	.07
CaO	2.36	2.09	1.96	2.25	2.44	2.02	1.75	.90	.25
Na_2O	3.09	3.06	3.23	3.31	2.97	3.86	3.08	3.10	2.90
K_2O	4.05	3.99	4.19	4.01	3.86	3.65	4.04	5.45	5.05
P_2O_5	.16	.19	.19	.16	.18	.13	.16	–	–
H_2O+	–	–	–	–	–	–	–	.85	.60
H_2O-	–	–	–	–	–	–	–	.05	.02
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	.94	.83	1.36	.99	.99	1.13	1.05	–	–
TOTAL	99.87	99.97	99.70	99.35	99.95	99.86	100.04	99.93	100.48
Fe_2O_3t	4.36	4.82	3.79	4.14	4.97	3.21	4.37	3.10	1.30
A/CNK	1.1	1.2	1.2	1.1	1.2	1.1	1.2	1.1	1.3
DI	76.9	77.6	79.6	77.1	75.2	80.9	79.0	89.4	94.7
Ba	676.	587.	545.	694.	616.	778.	601.	580.	–
Rb	158.	166.	200.	153.	153.	130.	170.	230.	760.
Sr	331.	215.	219.	377.	232.	631.	265.	80.	–
Y	30.	35.	28.	28.	36.	24.	33.	–	–
Zr	201.	207.	165.	195.	219.	160.	204.	–	–
Nb	13.	15.	14.	13.	15.	10.	14.	–	–
Th	11.00	16.00	16.00	8.00	15.00	2.00	13.00	–	–
Pb	26.	29.	37.	20.	23.	20.	22.	–	–
Ga	22.	22.	22.	23.	16.	20.	19.	–	–
Zn	66.0	126.0	64.0	57.0	66.0	50.0	62.0	–	–
Cu	14.0	17.0	23.0	10.0	16.0	12.0	11.0	–	–
Ni	22.0	26.0	23.0	23.0	30.0	17.0	28.0	–	–
TiO_2	.64	.71	.54	.63	.70	.53	.73	–	–
V	73.	77.	62.	73.	78.	54.	88.	–	–
Cr	45.	46.	37.	49.	53.	38.	52.	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	80.0	250.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MME10A MENT MONG	MME13 MENT MONG	MME14 MENT SYEG	MME15 MENT MONG	MME16 MENT SYEG	MME17 MENT MONG	MME18 MENT MONG	MME2 MENT SYEG	MME4 MENT MONG
SiO_2	75.60	76.30	71.90	72.20	75.30	70.20	73.70	74.30	76.10
TiO_2	.25	–	.45	.40	.15	.45	.35	.35	.20
Al_2O_3	13.80	13.60	14.00	13.60	13.50	15.30	13.90	13.50	13.50
Fe_2O_3	1.20	.70	.94	1.01	.95	1.11	.93	1.03	.61
FeO	.36	–	1.95	1.16	–	1.16	1.23	.87	.58
MnO	.03	–	.04	.04	–	.04	.03	.03	.02
MgO	.10	.05	.40	.22	.07	.40	.20	.20	.08
CaO	.15	–	.65	.75	.30	.85	.75	.55	.40
Na_2O	2.70	2.90	2.40	3.10	3.40	3.15	3.15	3.10	3.20
K_2O	5.45	5.55	5.65	5.55	5.65	5.85	5.60	5.45	5.05
P_2O_5	–	–	–	–	–	–	–	–	–
H_2O+	1.00	1.06	1.50	1.10	.90	.96	.70	.70	.70
H_2O-	–	.14	.24	–	.11	.06	.05	.03	.05
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	100.64	100.30	100.12	99.13	100.33	99.53	100.59	100.11	100.49
Fe_2O_3t	1.60	.70	3.10	2.30	.95	2.40	2.30	2.00	1.25
A/CNK	1.3	1.3	1.2	1.1	1.1	1.2	1.1	1.1	1.2
DI	94.6	96.6	88.6	90.7	96.3	89.0	92.0	92.9	94.7
Ba	100.	–	560.	320.	–	500.	430.	770.	1540.
Rb	590.	345.	230.	250.	355.	260.	235.	260.	305.
Sr	445.	–	60.	40.	185.	75.	45.	45.	40.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	150.0	50.0	95.0	90.0	50.0	150.0	80.0	115.0	130.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MME5 MENT MONG	MME6 MENT MONG	MMG1 MENT GRAN	MMG2 MENT GRAN	MMM15 MENT GRAN	MMM31 MENT GRAN	MMN66 MENT GRAN	MMN72 MENT GRAN	MMQ19 MENT GRAN
SiO_2	71.90	70.20	71.17	66.73	77.29	76.63	73.98	74.26	76.89
TiO_2	.25	.55	.46	.78	.03	.08	.04	.04	–
Al_2O_3	14.70	15.00	14.60	17.22	12.75	12.49	14.69	14.71	12.98
Fe_2O_3	.93	1.12	2.86	2.08	.76	.53	1.25	.92	.49
FeO	1.23	2.32	–	–	–	–	–	–	–
MnO	.04	.07	1.07	.04	.03	.02	.02	.01	.02
MgO	.40	.75	1.07	.72	–	.03	.09	.07	.03
CaO	.90	1.75	1.08	1.95	–	.09	.14	.16	–
Na_2O	3.20	3.50	2.96	2.76	2.36	3.10	3.15	3.69	2.97
K_2O	5.85	4.45	4.68	6.72	5.13	5.17	4.96	4.53	5.68
P_2O_5	–	–	–	–	–	–	–	–	–
H_2O+	.59	.55	.50	.61	–	–	1.32	1.05	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	1.51	.73	–	–	.79
TOTAL	99.99	100.26	100.45	99.61	99.86	98.87	99.64	99.44	99.85
Fe_2O_3t	2.30	3.70	2.86	2.08	.76	.53	1.25	.92	.49
A/CNK	1.1	1.1	1.2	1.1	1.4	1.2	1.4	1.3	1.2
DI	90.0	83.1	85.3	83.3	94.2	95.4	93.4	94.0	96.5
Ba	425.	660.	–	–	26.	70.	–	–	45.
Rb	240.	245.	–	–	275.	233.	–	–	346.
Sr	80.	115.	–	–	19.	37.	–	–	15.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	14.	24.	–	–	10.
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	75.0	100.0	–	–	46.0	23.0	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	20.0	20.0	–	–	–
F	–	–	–	–	150.	40.	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	43.0	3.7	–	–	–
Sn	–	–	–	–	–	20.0	–	–	–
Mo	–	–	–	–	.30	.20	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MMQ20 MENT GRAN	MMT56 MENT GRAN	MMT81 MENT GRAN	MMT82 MENT GRAN	MMZ10 MENT GRAN	MMZ10A MENT GRAN	MMZ11 MENT GRAN	MMZ12 MENT GRAN	MMZ14 MENT GRAN
SiO_2	77.61	75.38	69.74	74.35	74.27	73.35	75.96	76.64	75.83
TiO_2	-	.08	.62	.34	.06	.10	.05	.07	.07
Al_2O_3	12.88	12.99	14.30	12.85	14.15	14.31	13.20	13.09	13.62
Fe_2O_3	.44	1.68	4.05	2.28	1.09	1.21	1.07	1.50	1.26
FeO	-	-	-	-	-	-	-	-	-
MnO	.02	.05	.06	.05	.04	.08	.03	.04	.03
MgO	.03	.03	.85	.31	.03	-	.03	.03	.03
CaO	.06	.24	1.71	.70	.26	.01	.23	.24	.23
Na_2O	3.04	3.16	3.18	3.07	2.91	2.90	3.15	1.84	2.78
K_2O	5.10	4.84	4.74	4.87	5.61	5.75	4.82	4.46	4.38
P_2O_5	-	.04	.13	.04	-	-	-	-	-
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.84	1.02	.87	.87	1.14	1.06	1.13	1.78	1.35
TOTAL	100.02	99.51	100.25	99.73	99.56	98.77	99.67	99.69	99.58
Fe_2O_3t	.44	1.68	4.05	2.28	1.09	1.21	1.07	1.50	1.26
A/CNK	1.2	1.2	1.1	1.1	1.3	1.3	1.2	1.6	1.4
DI	96.1	93.4	83.5	90.8	93.0	93.0	93.8	90.2	91.8
Ba	13.	69.	471.	202.	-	61.	-	-	-
Rb	387.	354.	266.	316.	-	1115.	-	-	-
Sr	11.	25.	151.	66.	-	25.	-	-	-
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	10.	32.	97.	55.	-	12.	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	478.0	478.0	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	20.0	20.0	-	-	-
F	-	-	-	-	650.	650.	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	26.5	26.5	-	-	-
Sn	-	2.0	7.0	11.0	6.0	-	-	-	-
Mo	-	-	-	-	.10	.10	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MMZ16 MENT GRAN	MMZ17 MENT GRAN	MMZ18 MENT GRAN	MMZ18A MENT GRAN	MMZ19 MENT GRAN	MMZ19A MENT GRAN	MMZ21 MENT GRAN	MMZ21A MENT GRAN	MMZ26 MENT GRAN
SiO_2	74.12	75.44	73.79	74.17	75.51	75.56	75.14	74.96	74.53
TiO_2	.06	.05	.17	.17	.16	.07	.08	.06	.03
Al_2O_3	14.09	13.88	14.11	13.41	13.42	13.17	13.64	13.85	14.31
Fe_2O_3	.97	.70	1.89	1.70	1.20	1.28	1.36	1.31	1.33
FeO	-	-	-	-	-	-	-	-	-
MnO	.01	.02	.03	.06	.04	.02	.06	.03	.03
MgO	.08	.03	.03	.13	-	.04	-	.03	.03
CaO	.07	.11	.60	.37	.04	.29	-	.19	.08
Na_2O	1.01	2.97	2.96	3.01	2.87	2.77	3.11	3.14	3.15
K_2O	7.32	5.26	4.96	4.88	5.12	5.15	4.73	4.85	4.68
P_2O_5	-	-	-	.06	.07	-	.15	-	-
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.50	1.22	1.18	1.09	1.15	1.13	1.18	1.27	1.73
TOTAL	99.23	99.68	99.72	99.05	99.58	99.48	99.45	99.69	99.90
Fe_2O_3t	.97	.70	1.89	1.70	1.20	1.28	1.36	1.31	1.33
A/CNK	1.5	1.3	1.3	1.2	1.3	1.2	1.3	1.3	1.4
DI	91.8	94.0	90.6	91.5	93.8	92.9	93.2	92.9	92.4
Ba	-	-	137.	-	44.	-	27.	-	-
Rb	-	-	557.	-	667.	-	774.	-	-
Sr	-	-	40.	-	10.	-	33.	-	-
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	22.	-	10.	-	18.	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	312.0	312.0	89.0	89.0	327.0	327.0	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	22.0	22.0	26.0	26.0	20.0	20.0	-
F	-	-	300.	330.	220.	220.	330.	330.	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	12.0	12.0	12.6	12.6	11.3	11.3	-
Sn	-	-	-	-	17.0	17.0	-	-	6.0
Mo	-	-	.50	.50	.10	.10	.20	.20	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MMZ27 MENT GRAN	MMZ28 MENT GRAN	MMZ29 MENT GRAN	MMZ30 MENT GRAN	MMZ31 MENT GRAN	MMZ35 MENT GRAN	MMZ38 MENT GRAN	MMZ40 MENT GRAN	MMZ41 MENT GRAN
SiO_2	74.75	76.28	74.72	73.90	74.58	76.40	74.89	73.56	73.14
TiO_2	.03	.03	.04	.02	.03	.02	.03	–	.17
Al_2O_3	14.39	13.12	14.20	13.95	14.46	14.06	14.04	15.01	14.51
Fe_2O_3	1.02	.93	1.09	1.12	.92	1.11	1.07	1.71	1.21
FeO	–	–	–	–	–	–	–	–	–
MnO	.03	.02	.03	.06	.02	.08	.02	.12	.08
MgO	.03	.03	.05	–	.03	–	.07	.08	–
CaO	.21	.27	.17	.02	.18	.03	.14	–	–
Na_2O	3.74	2.49	2.19	2.77	3.75	1.41	3.39	3.86	3.55
K_2O	4.42	4.61	5.06	5.44	4.23	5.16	4.77	4.61	4.72
P_2O_5	–	–	–	.16	–	.22	–	.13	.12
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	1.18	1.38	1.83	1.24	1.17	1.67	1.32	1.39	1.18
TOTAL	99.80	99.16	99.38	98.68	99.37	100.16	99.74	100.47	98.68
Fe_2O_3t	1.02	.93	1.09	1.12	.92	1.11	1.07	1.71	1.21
A/CNK	1.3	1.4	1.5	1.3	1.3	1.8	1.3	1.3	1.3
DI	93.3	91.8	90.6	92.6	92.9	90.9	93.4	93.2	92.4
Ba	–	–	–	48.	–	52.	–	28.	20.
Rb	–	–	–	905.	–	751.	–	1473.	894.
Sr	–	–	–	22.	–	66.	–	25.	20.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	28.	–	27.	–	20.	21.
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	279.0	–	172.0	–	1451.0	453.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	20.0	–	20.0	–	20.0	22.0
F	–	–	–	300.	–	300.	–	1000.	520.
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	14.5	–	104.0	–	42.5	17.9
Sn	–	–	–	44.0	–	930.0	–	37.0	37.0
Mo	–	–	–	.10	–	.20	–	.10	.50
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MMZ63 MENT GRAN	MMZ64 MENT GRAN	MOU430 OULM GRAN	MOU431 OULM GRAN	MOU432 OULM GRAN	MOU433 OULM GRAN	MOU434 OULM GRAN	MOU435 OULM GRAN	MOU436 OULM GRAN
SiO_2	75.70	77.42	73.10	73.00	72.70	72.90	72.80	74.50	74.85
TiO_2	.06	–	.05	–	.08	.12	–	.15	–
Al_2O_3	12.77	12.19	15.73	15.94	17.10	14.74	14.52	14.49	14.85
Fe_2O_3	.76	.18	.12	.48	–	.29	.20	.24	.25
FeO	–	–	1.35	.75	.65	.91	.69	.60	.52
MnO	.04	.02	–	–	–	.07	.07	–	.13
MgO	–	–	.73	.73	.54	.43	.77	.87	.29
CaO	.03	.22	.44	.27	.70	1.17	.92	.82	.85
Na_2O	2.95	3.50	4.24	4.46	3.29	3.65	4.05	2.81	4.20
K_2O	5.41	4.79	2.36	2.50	3.52	4.30	3.75	3.69	3.45
P_2O_5	–	–	–	–	.08	.37	.29	.11	.10
H_2O+	–	–	–	–	–	.50	.23	–	.36
H_2O-	–	–	–	–	–	.03	–	–	.07
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	1.03	.74	2.00	1.60	1.80	–	–	1.60	–
TOTAL	98.75	99.06	100.12	99.73	100.46	99.48	98.29	99.88	99.92
Fe_2O_3t	.76	.18	1.62	1.31	.72	1.30	.97	.91	.83
A/CNK	1.2	1.1	1.5	1.5	1.6	1.2	1.2	1.4	1.2
DI	94.7	96.2	86.2	87.9	86.2	89.3	88.7	86.6	91.1
Ba	59.	47.	–	–	–	–	–	–	–
Rb	351.	211.	–	–	–	–	–	–	–
Sr	16.	10.	–	–	–	–	–	–	–
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	10.	10.	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	68.0	23.0	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	20.0	20.0	–	–	–	–	–	–	–
F	44.	10.	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	5.1	56.0	–	–	–	–	–	–	–
Sn	–	17.0	–	–	–	–	–	–	–
Mo	.20	.30	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MOU437 OULM GRAN	MOU459 OULM GRAN	MOU460 OULM GRAN	MOU461 OULM GRAN	MOU462 OULM GRAN	MOU463 OULM GRAN	MOU464 OULM GRAN	MOU465 OULM GRAN	MOU466 OULM GRAN
SiO_2	75.00	70.05	65.10	71.85	71.20	74.35	72.20	72.95	73.42
TiO_2	.47	.30	.60	.15	.21	.15	.18	.15	.15
Al_2O_3	15.35	17.40	15.10	15.45	15.65	14.77	15.05	15.02	15.34
Fe_2O_3	1.07	.70	2.17	.33	.32	1.34	.35	-	.45
FeO	-	.97	2.01	.60	1.17	.67	.87	.81	.75
MnO	-	-	.10	-	.06	-	.04	-	-
MgO	.34	.80	2.17	.76	.57	.70	.90	.71	.51
CaO	.70	1.70	2.97	1.70	1.30	1.28	1.45	1.42	1.22
Na_2O	3.08	2.76	3.61	3.03	2.90	1.54	3.30	3.23	2.49
K_2O	3.25	1.90	4.41	3.18	5.30	4.33	4.35	3.72	4.60
P_2O_5	.09	.32	.33	.20	-	-	.30	.20	.12
H_2O+	-	-	1.02	-	.41	-	.45	-	-
H_2O-	-	-	.20	-	-	-	.10	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.05	3.40	-	2.50	-	1.00	-	2.10	1.80
TOTAL	100.40	100.30	99.79	99.75	99.09	100.13	99.54	100.31	100.85
Fe_2O_3t	1.07	1.78	4.40	1.00	1.62	2.08	1.32	.90	1.28
A/CNK	1.6	1.8	.9	1.3	1.2	1.6	1.2	1.3	1.4
DI	88.2	77.1	75.7	82.0	85.9	83.7	86.4	85.1	86.2
Ba	-	-	-	-	-	-	-	-	-
Rb	-	-	-	-	-	-	-	-	-
Sr	-	-	-	-	-	-	-	-	-
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MOU467 OULM GRAN	MOU468 OULM GRAN	MOU469 OULM GRAN	MOU470 OULM GRAN	MOU471 OULM GRAN	MOU472 OULM GRAN	MOU473 OULM GRAN	MOU474 OULM GRAN	MOU475 OULM GRAN
SiO_2	71.85	73.70	71.70	65.66	72.25	72.90	73.70	73.10	68.20
TiO_2	.16	.15	.05	.10	.11	.21	-	.15	.40
Al_2O_3	15.65	14.59	15.18	18.90	15.45	15.00	15.60	14.12	18.24
Fe_2O_3	.42	.05	-	.66	.47	.31	-	.18	.37
FeO	1.04	1.12	.97	1.20	.42	1.10	.60	1.94	1.96
MnO	.07	-	-	-	.07	.08	-	-	.06
MgO	.57	.29	1.30	.40	.70	.93	.54	.76	.84
CaO	1.42	1.13	1.47	1.39	1.15	1.20	.90	.81	1.25
Na_2O	3.15	1.59	3.02	3.40	3.05	2.85	3.82	1.75	3.05
K_2O	4.65	4.67	4.10	6.66	4.05	4.90	4.06	5.48	5.20
P_2O_5	.30	.16	-	-	.24	.20	-	-	.27
H_2O+	.63	-	-	-	.65	.33	-	-	.50
H_2O-	-	-	-	-	.18	.10	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	2.00	1.90	2.00	-	-	1.95	2.20	-
TOTAL	99.91	99.45	99.69	100.37	98.79	100.11	101.17	100.49	100.34
Fe_2O_3t	1.57	1.29	1.08	1.99	.94	1.53	.67	2.33	2.55
A/CNK	1.2	1.5	1.3	1.2	1.3	1.2	1.3	1.4	1.4
DI	86.7	84.4	82.4	84.3	86.5	86.9	89.0	84.8	83.1
Ba	-	-	-	-	-	-	-	-	-
Rb	-	-	-	-	-	-	-	-	-
Sr	-	-	-	-	-	-	-	-	-
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MOU476 OULM GRAN	MQR2 AEBA MONG	MQR4 AEBA MONG	MQR6 AEBA MONG	MSDB1 SDBR MONG	MSDB10 SDBR MONG	MSDB11 SDBR MONG	MSDB12 SDBR MONG	MSDB13 SDBR MONG
SiO_2	75.65	75.64	76.21	76.64	76.81	75.01	76.02	76.24	76.63
TiO_2	.10	.07	.06	.10	.02	.09	.20	.03	.15
Al_2O_3	14.85	12.43	13.17	12.39	13.39	13.56	13.00	12.81	12.25
Fe_2O_3	1.10	1.22	.96	1.32	.40	.97	1.49	.90	1.18
FeO	.81	–	–	–	–	–	–	–	–
MnO	–	.03	.03	.04	.01	.03	.02	.02	.02
MgO	.49	.06	.03	.10	.01	.05	.21	.01	.14
CaO	1.75	1.92	.70	.71	.37	.88	.79	1.21	.71
Na_2O	2.01	3.60	3.64	3.73	4.23	3.91	3.45	4.08	3.39
K_2O	1.15	4.64	4.94	4.54	4.64	4.73	4.89	4.32	4.90
P_2O_5	–	.02	.03	.02	.03	.10	.06	.02	.05
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	2.00	.31	.39	.38	.29	.56	.41	.35	.35
TOTAL	99.91	99.94	100.16	99.97	100.20	99.89	100.54	99.99	99.77
Fe_2O_3t	2.00	1.22	.96	1.32	.40	.97	1.49	.90	1.18
A/CNK	1.9	.9	1.0	1.0	1.1	1.0	1.1	.9	1.0
DI	78.7	93.0	94.7	94.3	96.9	93.5	93.5	94.3	94.2
Ba	–	51.	84.	13.	36.	157.	234.	7.	184.
Rb	–	284.	291.	289.	209.	222.	180.	367.	187.
Sr	–	17.	28.	10.	10.	67.	75.	4.	50.
Y	–	89.	62.	79.	34.	23.	25.	51.	30.
Zr	–	105.	80.	90.	43.	74.	138.	62.	117.
Nb	–	33.	17.	19.	20.	27.	31.	36.	22.
Th	–	45.00	34.00	53.00	15.00	29.00	36.00	32.00	36.00
Pb	–	17.	28.	18.	27.	13.	8.	26.	12.
Ga	–	20.	18.	19.	19.	20.	17.	23.	17.
Zn	–	18.0	15.0	18.0	13.0	13.0	20.0	17.0	14.0
Cu	–	4.0	1.0	–	–	5.0	1.0	–	2.0
Ni	–	47.0	36.0	45.0	21.0	20.0	15.0	40.0	17.0
TiO_2	–	.06	.05	.06	–	.09	.23	.02	.14
V	–	1.	4.	2.	2.	6.	9.	4.	4.
Cr	–	6.	3.	12.	6.	7.	8.	10.	4.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MSDB14 SDBR MONG	MSDB2A SDBR MONG	MSDB2B SDBR MONG	MSDB3 SDBR MONG	MSDB4 SDBR MONG	MSDB6 SDBR MONG	MSDB7 SDBR SYEG	MSDB8 SDBR MONG	MSDB9 SDBR MONG
SiO_2	77.85	74.74	77.93	77.39	76.96	76.48	76.57	76.98	77.69
TiO_2	.09	.17	.09	.07	.07	.12	.10	.09	.07
Al_2O_3	12.88	13.29	12.91	12.62	12.63	12.73	12.28	12.73	12.50
Fe_2O_3	.91	1.41	.92	1.01	.83	1.09	1.01	.77	.44
FeO	-	-	-	-	-	-	-	-	-
MnO	.02	.03	.01	.02	.01	.02	.02	.01	.01
MgO	.01	.16	.01	.01	.01	.10	.05	.01	.01
CaO	.49	.80	.45	.42	.33	.62	1.36	.58	.44
Na_2O	3.29	3.69	3.05	3.70	3.93	3.53	3.42	3.57	3.73
K_2O	4.73	5.10	5.19	4.69	4.69	4.91	4.92	4.88	4.71
P_2O_5	.03	.04	.02	.01	.02	.06	.02	.02	.01
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.27	.32	.32	.33	.32	.31	.29	.33	.35
TOTAL	100.57	99.75	100.90	100.27	99.80	99.97	100.04	99.97	99.96
Fe_2O_3t	.91	1.41	.92	1.01	.83	1.09	1.01	.77	.44
A/CNK	1.1	1.0	1.1	1.1	1.0	1.0	.9	1.0	1.0
DI	95.4	93.3	95.9	96.1	96.4	94.7	94.2	95.4	96.4
Ba	57.	218.	58.	4.	15.	108.	78.	165.	70.
Rb	279.	181.	204.	338.	368.	231.	150.	187.	245.
Sr	15.	60.	21.	4.	9.	35.	18.	16.	33.
Y	41.	30.	25.	36.	53.	33.	19.	25.	26.
Zr	96.	136.	78.	82.	134.	101.	87.	84.	83.
Nb	30.	27.	32.	52.	67.	29.	12.	37.	37.
Th	42.00	23.00	35.00	51.00	55.00	43.00	41.00	43.00	43.00
Pb	19.	11.	16.	17.	23.	21.	16.	17.	18.
Ga	21.	20.	17.	22.	22.	19.	18.	18.	21.
Zn	15.0	18.0	21.0	14.0	11.0	22.0	27.0	15.0	17.0
Cu	-	1.0	9.0	-	1.0	2.0	6.0	2.0	-
Ni	31.0	17.0	20.0	31.0	42.0	21.0	11.0	19.0	21.0
TiO_2	.08	.20	.07	.08	.06	.10	.08	.09	.06
V	7.	11.	4.	-	-	3.	1.	1.	1.
Cr	4.	10.	11.	4.	9.	10.	22.	8.	7.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MTI61 TICH GRAN	MTI62 TICH GRAN	MTI710 TICH GRAN	MTI711 TICH GRAN	MTI712 TICH GRAN	MTI719 TICH GRAN	MZA1 ZAER GRAN	MZA102 ZAER GRAN	MZA104 ZAER GRAN
SiO_2	71.01	75.08	70.22	69.41	69.41	67.32	69.96	77.07	68.61
TiO_2	.36	.14	.48	.51	.45	.43	.35	.09	.56
Al_2O_3	13.92	13.14	14.12	14.88	15.34	14.92	15.16	12.64	15.51
Fe_2O_3	.75	.39	.98	1.07	.49	.67	2.28	.94	3.79
FeO	1.10	.50	1.65	1.87	1.60	1.60	-	-	-
MnO	.06	.02	.04	.06	.09	.10	.05	.02	.08
MgO	1.35	1.76	2.14	1.50	.80	1.80	.49	.13	1.58
CaO	1.16	.75	1.79	2.16	2.04	1.98	1.40	.46	2.46
Na_2O	4.27	3.39	4.44	4.54	4.53	4.72	3.70	3.26	3.59
K_2O	3.91	5.00	3.35	3.31	3.47	3.19	3.94	4.63	3.25
P_2O_5	.10	-	.13	.15	.13	.12	.25	.36	.37
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.13	.06	.16	.22	.19	.19	1.93	.61	.65
TOTAL	98.12	100.23	99.50	99.68	98.54	97.04	99.51	100.21	100.45
Fe_2O_3t	1.97	.95	2.81	3.15	2.27	2.45	2.28	.94	3.79
A/CNK	1.0	1.1	1.0	1.0	1.0	1.0	1.2	1.1	1.1
DI	85.8	90.0	81.6	81.0	82.5	79.0	84.9	95.1	78.3
Ba	-	-	-	-	-	-	355.	330.	691.
Rb	-	-	-	-	-	-	287.	255.	122.
Sr	-	-	-	-	-	-	130.	130.	324.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	73.0	89.0	60.0
Cu	-	-	-	-	-	-	10.0	37.0	10.0
Ni	-	-	-	-	-	-	10.0	10.0	11.0
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	34.	16.	69.
Cr	-	-	-	-	-	-	10.	10.	41.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	10.	10.	10.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	1.00	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	163.0	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MZA106 ZAER GRAN	MZA107 ZAER GRAN	MZA108 ZAER GRAN	MZA109 ZAER GRAN	MZA112 ZAER GRAN	MZA113 ZAER GRAN	MZA114 ZAER GRAN	MZA115 ZAER GRAN	MZA116 ZAER GRAN
SiO_2	73.61	73.38	68.24	69.99	68.85	71.54	73.72	75.26	74.25
TiO_2	.13	.24	.54	.37	.51	.29	.02	.08	.12
Al_2O_3	14.14	13.94	15.64	14.66	15.67	14.96	15.14	14.14	14.03
Fe_2O_3	1.18	1.55	3.56	2.23	3.58	1.90	.84	.73	.93
FeO	–	–	–	–	–	–	–	–	–
MnO	.04	.05	.07	.05	.07	.05	.07	.04	.04
MgO	.14	.02	1.52	.52	1.34	.44	–	.02	.04
CaO	.26	.65	3.01	1.43	2.24	1.08	–	.29	.08
Na_2O	3.19	3.31	3.90	3.40	4.02	3.39	3.62	3.29	2.92
K_2O	4.62	4.40	2.40	4.01	2.89	4.60	3.83	5.00	4.89
P_2O_5	.18	.15	.13	.24	.20	.24	.36	.24	.37
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	2.76	2.49	1.04	2.31	1.07	.75	1.62	1.39	1.57
TOTAL	100.25	100.18	100.05	99.21	100.44	99.24	99.22	100.48	99.24
Fe_2O_3t	1.18	1.55	3.56	2.23	3.58	1.90	.84	.73	.93
A/CNK	1.3	1.2	1.1	1.2	1.1	1.2	1.5	1.3	1.4
DI	91.4	90.3	75.2	84.2	79.3	87.8	91.3	94.4	92.1
Ba	183.	263.	675.	473.	536.	442.	24.	193.	275.
Rb	430.	364.	96.	306.	239.	358.	801.	468.	408.
Sr	47.	75.	400.	156.	286.	142.	100.	52.	51.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	42.0	51.0	71.0	80.0	79.0	75.0	103.0	44.0	59.0
Cu	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Ni	10.0	10.0	13.0	10.0	15.0	10.0	10.0	10.0	10.0
TiO_2	–	–	–	–	–	–	–	–	–
V	11.	11.	88.	52.	71.	45.	24.	23.	28.
Cr	10.	10.	40.	16.	32.	14.	17.	10.	10.
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	10.	10.	10.	10.	10.	10.	10.	10.	10.
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	2.00
W	–	–	–	–	–	–	2.9	–	–
Sn	20.0	–	–	12.0	–	14.0	66.0	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MZA117 ZAER GRAN	MZA118 ZAER GRAN	MZA119 ZAER GRAN	MZA121 ZAER GRAN	MZA122 ZAER GRAN	MZA124 ZAER GRAN	MZA13 ZAER GRAN	MZA134 ZAER GRAN	MZA15 ZAER GRAN
SiO_2	68.84	73.18	70.47	76.92	74.56	64.30	74.76	73.27	74.52
TiO_2	.41	.04	.40	.03	.13	.68	.03	.11	.01
Al_2O_3	15.52	15.29	15.21	14.05	14.21	16.82	14.43	14.09	13.96
Fe_2O_3	2.81	1.39	2.71	.66	1.03	4.82	.60	1.23	.92
FeO	-	-	-	-	-	-	-	-	-
MnO	.06	.05	.05	.07	.03	.11	.08	.04	.03
MgO	1.08	-	1.09	-	.13	2.11	-	.23	.01
CaO	2.31	-	1.82	-	.17	1.86	-	.37	.12
Na_2O	3.88	3.50	3.52	3.67	3.37	3.04	4.23	3.07	2.30
K_2O	3.69	4.09	4.22	4.06	4.88	4.42	3.90	5.03	5.28
P_2O_5	.70	.41	-	-	.22	.29	.03	.02	.19
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.04	1.68	.49	.78	1.52	2.02	1.53	1.00	2.14
TOTAL	100.34	99.63	99.98	100.24	100.25	100.47	99.59	98.46	99.48
Fe_2O_3t	2.81	1.39	2.71	.66	1.03	4.82	.60	1.23	.92
A/CNK	1.1	1.5	1.1	1.4	1.3	1.3	1.3	1.3	1.4
DI	82.2	91.0	83.0	95.1	93.4	75.2	94.1	90.8	91.6
Ba	723.	34.	555.	27.	76.	728.	28.	144.	157.
Rb	155.	-	166.	418.	370.	297.	423.	392.	414.
Sr	319.	681.	287.	16.	27.	380.	15.	44.	41.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	56.0	-	43.0	46.0	58.0	122.0	10.0	-	67.0
Cu	10.0	27.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Ni	10.0	10.0	10.0	10.0	10.0	34.0	10.0	10.0	10.0
TiO_2	-	-	-	-	-	-	-	-	-
V	64.	10.	37.	10.	15.	88.	10.	21.	17.
Cr	30.	10.	26.	10.	10.	59.	10.	10.	10.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	10.	62.	10.	10.	10.	10.	10.	10.	10.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	3.10	-	-	-	-	-	-	-	-
W	-	.3	-	2.4	1.2	-	-	1.2	-
Sn	-	-	-	-	18.0	-	30.0	-	2.5
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MZA164 ZAER GRAN	MZA22 ZAER GRAN	MZA23 ZAER GRAN	MZA28 ZAER GRAN	MZA36 ZAER GRAN	MZA7 ZAER GRAN	MZA8 ZAER GRAN	MZA85 ZAER GRAN	MZA88 ZAER GRAN
SiO_2	72.21	73.74	74.15	72.70	71.41	67.13	72.66	76.09	74.11
TiO_2	.29	.12	.06	.18	.04	.66	.24	.06	.08
Al_2O_3	14.58	14.34	13.83	15.21	16.08	15.62	13.90	14.31	14.57
Fe_2O_3	1.45	1.10	.17	1.16	.52	4.17	1.49	.44	.66
FeO	-	-	-	-	-	-	-	-	-
MnO	.05	.01	.02	-	.03	.07	.01	.07	.04
MgO	.26	.01	-	.05	.03	1.80	.02	-	.01
CaO	.47	.25	.32	.92	.08	2.95	.28	-	.13
Na_2O	3.12	2.93	4.10	3.70	3.08	3.74	2.56	4.06	3.30
K_2O	5.25	5.24	3.51	4.31	4.43	3.02	4.87	3.86	5.26
P_2O_5	.21	.19	.21	.19	1.45	.16	.43	.22	.29
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	1.25	2.47	.98	.84	2.69	.60	2.50	.79	1.33
TOTAL	99.14	100.40	97.35	99.26	99.84	99.92	98.96	99.90	99.78
Fe_2O_3t	1.45	1.10	.17	1.16	.52	4.17	1.49	.44	.66
A/CNK	1.3	1.3	1.2	1.2	1.6	1.1	1.4	1.3	1.3
DI	90.6	92.4	92.2	90.0	88.7	74.8	89.5	94.9	93.8
Ba	571.	159.	68.	414.	92.	633.	169.	74.	128.
Rb	445.	401.	197.	266.	380.	98.	364.	529.	384.
Sr	93.	47.	61.	130.	37.	385.	87.	13.	33.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	46.0	27.0	52.0	68.0	60.0	84.0	84.0	-
Cu	77.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Ni	10.0	10.0	10.0	10.0	10.0	30.0	10.0	10.0	10.0
TiO_2	-	-	-	-	-	-	-	-	-
V	39.	10.	17.	24.	10.	84.	14.	15.	10.
Cr	12.	10.	10.	12.	10.	43.	10.	10.	10.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	10.	10.	10.	10.	10.	10.	10.	10.	10.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	2.35	-	3.00	-	-	1.65	-	-
W	-	-	-	-	-	.5	-	-	-
Sn	-	22.0	-	-	-	15.0	28.0	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

MOROCCO

	MZA89 ZAER GRAN	MZA90 ZAER GRAN	MZA91 ZAER GRAN	MZA92 ZAER GRAN	MZA94 ZAER GRAN	MZA95 ZAER GRAN	MZA96 ZAER GRAN	MZA98 ZAER GRAN
SiO_2	74.15	72.75	64.93	68.85	75.19	60.48	65.70	69.07
TiO_2	.06	.14	.65	.78	–	1.13	.60	.51
Al_2O_3	14.25	13.71	15.93	12.50	14.34	17.17	16.11	14.98
Fe_2O_3	.79	1.27	4.15	5.47	.78	5.28	3.73	3.40
FeO	–	–	–	–	–	–	–	–
MnO	.06	.02	.06	.08	.04	.10	.05	.06
MgO	–	.01	1.78	2.14	–	3.17	1.58	1.34
CaO	–	.16	2.88	1.89	.23	4.49	3.10	2.26
Na_2O	2.34	2.73	3.57	2.54	3.38	3.37	3.89	3.60
K_2O	4.83	5.09	2.78	3.12	4.05	2.75	2.81	3.49
P_2O_5	.72	.39	.52	.44	.46	.33	.52	.49
H_2O+	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–
LOI	2.45	2.12	1.99	2.01	1.55	1.27	1.96	.98
TOTAL	99.65	98.39	99.24	99.82	100.02	99.54	100.05	100.18
Fe_2O_3t	.79	1.27	4.15	5.47	.78	5.28	3.73	3.40
A/CNK	1.6	1.3	1.1	1.1	1.4	1.0	1.1	1.1
DI	90.4	90.6	72.8	76.1	92.6	61.7	74.3	80.4
Ba	27.	211.	699.	534.	22.	589.	656.	700.
Rb	549.	431.	100.	156.	600.	82.	85.	129.
Sr	14.	50.	385.	218.	41.	488.	404.	356.
Y	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–
Zn	64.0	65.0	66.0	114.0	–	68.0	64.0	64.0
Cu	10.0	10.0	10.0	31.0	10.0	10.0	10.0	10.0
Ni	10.0	10.0	19.0	24.0	10.0	28.0	11.0	13.0
TiO_2	–	–	–	–	–	–	–	–
V	16.	20.	79.	99.	18.	144.	89.	71.
Cr	10.	10.	47.	54.	10.	78.	39.	36.
Hf	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–
Co	10.	10.	10.	21.	10.	28.	10.	10.
Li	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–
U	1.70	–	–	–	2.70	–	1.95	–
W	3.0	1.6	–	–	–	.8	.5	–
Sn	26.0	28.0	–	–	39.0	–	–	–
Mo	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	IBJ1 UNKN GRAN	IBJ10 UNKN GRAN	IBJ11 UNKN GRAN	IBJ12 UNKN GRAN	IBJ13 UNKN GRAN	IBJ14 UNKN GRAN	IBJ15 UNKN GRAN	IBJ16 UNKN GRAN	IBJ17 UNKN GRAN
SiO_2	67.50	68.47	69.04	67.78	67.91	67.31	69.00	68.86	70.63
TiO_2	.59	.71	.60	.58	.70	.62	.59	.61	.49
Al_2O_3	16.03	15.42	16.20	15.41	14.89	14.73	15.07	14.36	14.50
Fe_2O_3	3.92	3.72	3.39	4.36	3.69	4.59	3.28	4.11	3.00
FeO	-	-	-	-	-	-	1.17	-	-
MnO	.05	.05	.06	.06	.06	.07	.05	.06	.05
MgO	1.30	1.28	1.08	1.42	1.38	1.47	1.17	1.29	.98
CaO	2.05	2.04	1.76	2.05	1.57	2.09	1.36	2.21	1.71
Na_2O	3.27	3.25	3.48	3.12	2.83	2.96	3.01	3.12	2.82
K_2O	4.69	4.28	4.49	4.45	4.48	4.40	4.62	4.26	4.96
P_2O_5	.30	.27	.17	.27	.19	.20	.17	.26	.21
H_2O+	.86	.84	.56	1.03	1.36	1.62	1.53	1.17	.98
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.56	100.33	100.83	100.53	99.06	100.06	101.02	100.31	100.33
Fe_2O_3t	3.92	3.72	3.39	4.36	3.69	4.59	4.58	4.11	3.00
A/CNK	1.1	1.1	1.2	1.1	1.2	1.1	1.2	1.0	1.1
DI	81.1	81.1	83.2	80.4	81.0	79.5	83.7	81.0	84.7
Ba	599.	416.	397.	348.	391.	364.	381.	140.	396.
Rb	170.	223.	277.	257.	217.	238.	241.	253.	300.
Sr	175.	167.	140.	128.	136.	133.	141.	126.	132.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	43.	48.	55.	46.	49.	41.	47.	49.	52.
Ga	-	-	-	-	-	-	-	-	-
Zn	68.0	85.0	80.0	73.0	77.0	98.0	90.0	91.0	78.0
Cu	13.0	5.0	1.0	2.0	1.0	2.0	1.0	2.0	3.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	68.0	124.0	174.0	162.0	131.0	119.0	109.0	105.0	123.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IBJ18 UNKN GRAN	IBJ19 UNKN GRAN	IBJ2 UNKN GRAN	IBJ20 UNKN GRAN	IBJ21 UNKN GRAN	IBJ22 UNKN GRAN	IBJ23 UNKN GRAN	IBJ24 UNKN GRAN	IBJ25 UNKN GRAN
SiO_2	66.51	68.53	67.08	66.75	67.15	68.90	68.88	70.50	69.08
TiO_2	.71	.51	.71	.62	.95	.94	.54	.49	.57
Al_2O_3	15.12	14.80	15.41	14.77	14.05	14.13	15.64	12.60	14.61
Fe_2O_3	5.19	3.52	3.91	4.52	1.46	2.55	2.04	1.78	1.50
FeO	-	-	-	-	3.23	2.35	2.03	2.42	2.23
MnO	.07	.06	.06	.07	.06	.06	.06	.07	.12
MgO	1.71	1.10	1.33	1.36	2.00	1.64	1.38	1.59	.84
CaO	2.36	1.91	2.50	2.16	1.17	1.40	.93	1.42	1.50
Na_2O	2.98	3.30	3.46	3.21	3.01	2.23	3.15	3.21	3.02
K_2O	4.42	4.60	4.63	4.59	4.30	3.84	4.20	4.63	4.46
P_2O_5	.16	.21	.19	.36	.26	.24	.18	.31	.40
H_2O+	1.03	1.21	.76	1.31	1.68	1.71	1.03	.68	1.08
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.26	99.75	100.04	99.72	99.32	99.99	100.06	99.70	99.41
Fe_2O_3t	5.19	3.52	3.91	4.52	5.05	5.16	4.29	4.47	3.98
A/CNK	1.1	1.1	1.0	1.0	1.2	1.4	1.4	1.0	1.2
DI	77.2	82.7	79.7	80.2	79.2	79.0	82.7	83.6	82.9
Ba	371.	412.	608.	400.	451.	479.	522.	664.	428.
Rb	261.	239.	207.	249.	252.	167.	286.	252.	227.
Sr	140.	159.	145.	168.	190.	153.	245.	166.	127.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	61.	49.	55.	38.	44.	39.	30.	52.	45.
Ga	-	-	-	-	-	-	-	-	-
Zn	87.0	69.0	67.0	72.0	136.0	108.0	107.0	65.0	67.0
Cu	1.0	5.0	7.0	2.0	23.0	21.0	5.0	6.0	9.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	119.0	121.0	94.0	112.0	129.0	64.0	218.0	125.0	117.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IBM14 UNKN GRAN	IBM15 UNKN GRAN	IBM16 UNKN GRAN	IBM17 UNKN GRAN	IBM18 UNKN GRAN	IBM19 UNKN GRAN	IBM2 UNKN GRAN	IBM20 UNKN GRAN	IBM21 UNKN GRAN
SiO_2	70.36	65.89	67.26	67.21	66.59	66.27	68.08	66.19	65.49
TiO_2	.45	1.02	.66	.60	.99	.58	.89	.65	.84
Al_2O_3	15.06	16.59	14.72	15.17	12.83	12.50	14.25	16.85	16.95
Fe_2O_3	3.30	5.39	2.15	1.83	3.34	2.69	1.91	2.61	1.90
FeO	-	-	3.28	3.24	5.01	4.12	3.23	4.60	3.36
MnO	.04	.07	.08	.07	.12	.09	.05	.09	.10
MgO	1.04	2.02	2.45	2.16	2.76	2.83	1.76	1.41	3.27
CaO	1.30	.98	1.76	2.72	1.10	1.39	1.34	.93	1.63
Na_2O	3.14	2.50	2.35	2.42	2.42	2.68	2.86	2.08	2.62
K_2O	4.66	4.19	3.89	3.12	3.12	3.17	4.59	3.08	3.10
P_2O_5	.20	.29	.25	.41	.34	.25	.10	.29	.22
H_2O+	.78	1.07	1.13	1.08	1.38	2.69	1.29	.96	.83
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.33	100.01	99.98	100.03	100.00	99.26	100.35	99.74	100.31
Fe_2O_3t	3.30	5.39	5.79	5.43	8.90	7.26	5.50	7.72	5.63
A/CNK	1.2	1.6	1.3	1.2	1.4	1.2	1.2	2.0	1.6
DI	85.3	77.8	74.2	71.4	72.7	73.4	79.7	73.1	70.2
Ba	737.	495.	446.	636.	342.	516.	623.	321.	464.
Rb	141.	190.	108.	105.	131.	88.	171.	117.	129.
Sr	175.	147.	119.	171.	94.	93.	138.	98.	96.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	56.	62.	42.	40.	35.	40.	44.	43.	37.
Ga	-	-	-	-	-	-	-	-	-
Zn	73.0	115.0	100.0	107.0	135.0	122.0	97.0	119.0	132.0
Cu	20.0	23.0	17.0	27.0	45.0	15.0	22.0	31.0	39.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	64.0	120.0	94.0	79.0	93.0	142.0	94.0	130.0	120.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IBM22 UNKN GRAN	IBM23 UNKN GRAN	IBM24 UNKN GRAN	IBM25 UNKN GRAN	IBM26 UNKN GRAN	IBM27 UNKN GRAN	IBM28 UNKN GRAN	IBM29 UNKN GRAN	IBM3 UNKN GRAN
SiO_2	66.70	66.97	66.53	65.70	58.78	64.96	66.70	63.36	67.31
TiO_2	.76	.85	.85	.43	1.67	.81	.76	1.23	.59
Al_2O_3	15.92	15.70	15.35	16.25	16.68	15.85	15.79	17.52	14.03
Fe_2O_3	1.88	1.56	1.75	2.60	7.96	5.89	5.21	6.95	2.00
FeO	2.73	2.82	3.15	3.20	-	-	-	-	2.97
MnO	.09	.09	.08	.09	.09	.09	.06	.09	.01
MgO	2.83	2.78	2.42	1.92	2.78	2.63	1.90	2.38	1.51
CaO	1.29	1.82	1.26	1.30	4.44	1.90	1.50	.86	1.51
Na_2O	3.11	3.11	2.99	2.38	3.50	3.33	3.20	2.28	3.48
K_2O	3.10	3.61	3.34	3.18	2.38	2.98	3.54	3.33	4.22
P_2O_5	.29	.18	.26	.21	.31	.33	.31	.26	.19
H_2O+	1.15	.86	1.76	2.16	1.19	1.19	1.06	1.14	1.56
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.85	100.35	99.74	99.42	99.78	99.96	100.03	99.40	99.38
Fe_2O_3t	4.91	4.69	5.25	6.15	7.96	5.89	5.21	6.95	5.30
A/CNK	1.5	1.3	1.4	1.7	1.0	1.3	1.3	2.0	1.1
DI	75.0	74.6	75.7	73.7	60.9	73.8	78.2	72.5	80.3
Ba	443.	365.	408.	357.	501.	89.	260.	415.	643.
Rb	163.	128.	136.	120.	111.	149.	152.	108.	164.
Sr	85.	98.	83.	54.	311.	177.	90.	99.	206.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	41.	33.	42.	33.	38.	39.	75.	33.	40.
Ga	-	-	-	-	-	-	-	-	-
Zn	112.0	133.0	131.0	101.0	82.0	80.0	92.0	111.0	77.0
Cu	30.0	26.0	43.0	35.0	16.0	20.0	20.0	36.0	11.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	113.0	70.0	77.0	81.0	60.0	67.0	67.0	90.0	53.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IBM30 UNKN GRAN	IBM31 UNKN GRAN	IBM4 UNKN GRAN	IBM5 UNKN GRAN	IBM6 UNKN GRAN	IBM7 UNKN GRAN	IBM8 UNKN GRAN	IBM9 UNKN GRAN	IBP1 UNKN GRAN
SiO_2	64.95	65.53	67.12	65.50	65.16	65.22	65.41	66.97	74.15
TiO_2	1.27	1.03	.57	.46	.83	.34	.70	.73	.27
Al_2O_3	17.10	16.56	14.88	16.03	15.76	17.66	16.02	15.28	14.57
Fe_2O_3	5.73	4.42	2.11	1.72	2.09	1.43	1.95	2.31	1.00
FeO	-	-	3.11	3.10	2.34	1.43	2.97	3.02	-
MnO	.08	.04	.08	.09	.12	.07	.13	.10	.01
MgO	1.97	1.59	1.70	1.71	2.23	2.82	2.28	2.85	.53
CaO	1.42	2.32	1.26	2.80	2.25	1.75	1.26	1.68	.50
Na_2O	2.59	3.04	2.34	2.62	2.87	2.04	3.01	1.91	2.80
K_2O	3.76	4.56	4.64	4.31	4.38	4.37	3.76	3.61	4.36
P_2O_5	.33	.22	.26	.26	.22	.24	.16	.33	.23
H_2O+	1.36	1.00	1.43	1.21	1.30	2.11	2.55	1.00	1.26
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.56	100.31	99.50	99.81	99.55	99.48	100.20	99.79	99.68
Fe_2O_3t	5.73	4.42	5.56	5.16	4.69	3.02	5.25	5.66	1.00
A/CNK	1.6	1.2	1.3	1.1	1.2	1.6	1.4	1.5	1.4
DI	75.6	77.1	78.2	72.8	74.7	73.5	76.2	72.2	90.6
Ba	531.	629.	529.	560.	609.	403.	362.	344.	285.
Rb	132.	159.	137.	155.	175.	169.	188.	212.	310.
Sr	150.	139.	164.	116.	140.	72.	57.	172.	95.
Y	-	-	-	-	-	-	-	-	10.
Zr	-	-	-	-	-	-	-	-	110.
Nb	-	-	-	-	-	-	-	-	12.
Th	-	-	-	-	-	-	-	-	22.00
Pb	36.	39.	47.	51.	44.	37.	36.	33.	48.
Ga	-	-	-	-	-	-	-	-	1.
Zn	11.0	196.0	117.0	105.0	110.0	80.0	81.0	90.0	95.0
Cu	32.0	41.0	5.0	13.0	23.0	14.0	18.0	14.0	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	38.0
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	128.0	82.0	113.0	79.0	91.0	60.0	85.0	139.0	20.0
Be	-	-	-	-	-	-	-	-	4.0
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	10.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IBP10 UNKN GRAN	IBP11 UNKN GRAN	IBP12 UNKN GRAN	IBP13 UNKN GRAN	IBP14 UNKN GRAN	IBP15 UNKN GRAN	IBP16 UNKN GRAN	IBP17 UNKN GRAN	IBP18 UNKN GRAN
SiO_2	73.15	73.13	73.30	72.30	73.50	74.15	73.50	74.15	73.20
TiO_2	.20	.39	.20	.20	.24	.24	.20	.24	.31
Al_2O_3	14.79	14.46	14.79	14.79	14.46	14.46	15.11	14.57	15.11
Fe_2O_3	.82	1.48	.82	.86	.92	1.00	.70	.82	1.00
FeO	-	-	-	-	-	-	-	-	-
MnO	.01	.02	.02	.01	.01	.01	.01	.01	.01
MgO	.21	.61	.21	.25	.29	.40	.21	.40	.50
CaO	.36	.62	.36	.50	.55	.50	.43	.50	.50
Na_2O	3.63	3.30	3.40	3.30	3.40	3.03	3.16	3.03	2.80
K_2O	4.18	4.52	5.05	5.05	5.05	4.52	4.36	4.52	4.52
P_2O_5	.19	.19	.18	.24	.20	.19	.19	.24	.22
H_2O+	1.51	.97	1.45	1.95	1.37	1.20	1.43	1.37	1.14
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.05	99.69	99.78	99.45	99.99	99.70	99.30	99.85	99.31
Fe_2O_3t	.82	1.48	.82	.86	.92	1.00	.70	.82	1.00
A/CNK	1.3	1.3	1.3	1.3	1.2	1.3	1.4	1.4	1.5
DI	92.3	90.5	93.6	92.6	93.2	91.5	91.6	91.8	89.9
Ba	160.	250.	65.	230.	115.	170.	90.	240.	285.
Rb	310.	300.	405.	305.	355.	325.	385.	325.	340.
Sr	60.	80.	50.	80.	95.	60.	60.	80.	80.
Y	10.	10.	10.	12.	12.	10.	10.	10.	10.
Zr	70.	120.	65.	75.	75.	85.	75.	85.	115.
Nb	12.	16.	14.	15.	14.	15.	21.	16.	17.
Th	20.00	20.00	20.00	22.00	22.00	20.00	22.00	1.00	20.00
Pb	35.	35.	29.	29.	41.	41.	24.	24.	29.
Ga	1.	1.	1.	1.	1.	20.	1.	1.	1.
Zn	67.0	83.0	45.0	75.0	75.0	71.0	75.0	86.0	85.0
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	38.0	38.0	1.0	1.0	1.0	38.0	1.0	1.0	45.0
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	10.0	46.0	20.0	25.0	44.0	34.0	15.0	22.0	29.0
Be	6.0	4.0	6.0	4.0	4.0	3.0	4.0	3.0	4.0
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	10.0	13.0	15.0	10.0	10.0	1.0	10.0	10.0	10.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IBP51 UNKN GRAN	IBP6 UNKN GRAN	IBP7 UNKN GRAN	IBP8 UNKN GRAN	IBP9 UNKN GRAN	ICA1 UNKN GRAN	ICA10 UNKN GRAN	ICA11 UNKN GRAN	ICA12 UNKN GRAN
SiO_2	71.80	73.00	73.80	73.15	74.15	73.52	72.83	73.72	73.96
TiO_2	.05	.24	.20	.24	.16	.14	.28	.25	.17
Al_2O_3	16.60	14.79	14.46	14.89	14.46	14.53	13.61	14.09	13.72
Fe_2O_3	.66	.82	.82	1.00	.82	.51	.89	.79	.63
FeO	–	–	–	–	–	.54	.97	.82	.66
MnO	.09	.02	.01	.01	.01	.02	.02	.02	.02
MgO	.01	.29	.33	.25	.25	.26	.66	.45	.36
CaO	.43	.50	.62	.55	.43	.79	.77	.89	.70
Na_2O	4.42	2.80	3.16	3.16	3.40	3.51	3.11	3.19	3.35
K_2O	3.46	5.50	4.36	4.36	4.36	4.67	4.82	5.20	4.96
P_2O_5	.32	.20	.17	.17	.19	.07	.01	.14	.21
H_2O+	1.61	1.04	1.32	1.33	1.09	1.00	1.55	.52	2.21
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.45	99.20	99.25	99.11	99.32	99.56	99.52	100.08	100.95
Fe_2O_3t	.66	.82	.82	1.00	.82	1.11	1.97	1.70	1.36
A/CNK	1.4	1.3	1.3	1.4	1.3	1.2	1.2	1.1	1.1
DI	92.1	91.9	91.1	90.7	92.5	91.4	89.6	91.1	93.6
Ba	80.	230.	250.	250.	205.	210.	408.	262.	168.
Rb	–	405.	320.	310.	395.	147.	310.	402.	265.
Sr	195.	75.	65.	80.	55.	71.	108.	61.	48.
Y	1.	10.	10.	10.	10.	–	–	–	–
Zr	25.	85.	70.	80.	60.	–	–	–	–
Nb	25.	15.	17.	17.	16.	–	–	–	–
Th	20.00	20.00	20.00	26.00	20.00	–	–	–	–
Pb	10.	18.	29.	41.	18.	–	–	–	–
Ga	20.	1.	1.	1.	1.	–	–	–	–
Zn	145.0	71.0	71.0	83.0	67.0	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	150.0	45.0	45.0	38.0	58.0	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	275.0	25.0	12.0	51.0	35.0	46.0	60.0	106.0	84.0
Be	13.0	4.0	4.0	8.0	6.0	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	124.0	13.0	15.0	10.0	25.0	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICA13 UNKN GRAN	ICA14 UNKN GRAN	ICA15 UNKN GRAN	ICA16 UNKN GRAN	ICA17 UNKN GRAN	ICA18 UNKN GRAN	ICA19 UNKN GRAN	ICA2 UNKN GRAN	ICA21 UNKN GRAN
SiO_2	72.99	73.05	72.37	72.16	71.05	75.45	76.09	73.14	75.93
TiO_2	.16	.06	.16	.27	.44	.03	.07	.14	.03
Al_2O_3	14.98	14.89	15.01	14.92	14.93	14.01	13.51	14.86	12.92
Fe_2O_3	.56	1.35	1.23	1.32	1.07	.50	.58	.55	.34
FeO	.64	.20	.70	.89	1.14	.56	.66	.59	.40
MnO	.03	.03	.02	.03	.06	.04	.06	.02	.03
MgO	.31	.29	.39	.60	1.87	.25	.34	.30	.11
CaO	.42	.54	.55	.63	.79	.47	.53	.76	.29
Na_2O	2.53	3.18	2.76	2.88	2.43	3.14	3.28	3.25	3.28
K_2O	5.08	5.02	5.41	5.01	5.75	4.53	4.03	4.85	4.02
P_2O_5	.28	.21	.20	.21	.36	.25	.26	.07	.10
H_2O+	1.92	.87	1.17	1.16	.64	1.08	.51	1.23	2.07
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.90	99.69	99.97	100.08	100.53	100.31	99.92	99.76	99.52
Fe_2O_3t	1.27	1.57	2.01	2.31	2.34	1.12	1.31	1.20	.78
A/CNK	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.3
DI	91.2	91.7	90.8	89.5	86.3	93.2	92.4	90.9	94.2
Ba	201.	210.	220.	245.	398.	221.	220.	314.	103.
Rb	159.	152.	155.	197.	269.	142.	154.	215.	228.
Sr	50.	64.	57.	70.	64.	40.	59.	81.	4.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	81.0	52.0	95.0	91.0	166.0	55.0	66.0	98.0	96.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICA22 UNKN GRAN	ICA23 UNKN GRAN	ICA24 UNKN GRAN	ICA25 UNKN GRAN	ICA26 UNKN GRAN	ICA27 UNKN GRAN	ICA28 UNKN GRAN	ICA29 UNKN GRAN	ICA3 UNKN GRAN
SiO_2	72.17	72.21	75.02	74.72	70.90	74.67	72.73	73.56	74.94
TiO_2	.24	.21	.01	.08	.35	.13	.19	.05	.04
Al_2O_3	14.82	14.81	15.07	15.04	15.14	14.33	14.45	13.98	13.90
Fe_2O_3	2.13	.78	.24	.49	1.53	.61	1.00	1.03	.44
FeO	.01	.88	.29	.54	1.84	.67	.65	.49	.47
MnO	.02	.01	.02	.02	.07	.03	.06	.05	.01
MgO	.55	.67	.29	.21	1.27	.23	1.00	.42	.20
CaO	.63	.76	.49	.47	.61	.41	.65	.54	.75
Na_2O	2.67	2.76	3.04	2.83	2.72	3.02	2.84	2.79	2.79
K_2O	5.31	4.96	4.08	4.96	3.24	4.79	5.13	5.41	5.39
P_2O_5	.20	.24	.29	.32	.10	.22	.16	.15	.04
H_2O+	1.62	1.26	.71	.67	1.77	.92	1.15	1.54	1.03
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.37	99.55	99.55	100.35	99.54	100.03	100.01	100.01	100.00
Fe_2O_3t	2.14	1.76	.56	1.09	3.57	1.35	1.72	1.57	.96
A/CNK	1.3	1.3	1.5	1.4	1.7	1.3	1.3	1.2	1.2
DI	90.1	88.7	91.4	92.5	82.6	92.6	89.4	92.2	92.5
Ba	312.	424.	178.	197.	497.	283.	389.	727.	300.
Rb	197.	205.	194.	163.	135.	341.	283.	208.	164.
Sr	80.	97.	43.	50.	117.	24.	62.	200.	71.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	105.0	73.0	40.0	39.0	68.0	141.0	107.0	80.0	34.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICA30 UNKN GRAN	ICA31 UNKN GRAN	ICA32 UNKN GRAN	ICA33 UNKN GRAN	ICA34 UNKN GRAN	ICA35 UNKN GRAN	ICA36 UNKN GRAN	ICA37 UNKN GRAN	ICA38 UNKN GRAN
SiO_2	73.26	73.41	73.68	71.62	73.58	73.79	73.90	71.47	75.86
TiO_2	.11	.21	.07	.22	.11	.19	.14	.47	.31
Al_2O_3	14.50	13.63	14.96	15.15	15.07	15.13	15.06	15.11	13.80
Fe_2O_3	1.11	1.08	.42	.87	.45	.57	.36	1.18	1.09
FeO	.07	.79	.46	.96	.48	.63	.42	1.17	.83
MnO	.05	.04	.02	.02	.03	.03	.03	.06	.03
MgO	.34	.81	.30	.44	.26	.42	.31	.67	.47
CaO	.67	.60	.49	.60	.42	.35	.57	.65	.54
Na_2O	3.22	2.84	3.10	3.07	3.16	2.97	2.58	2.70	2.78
K_2O	4.40	4.96	4.87	5.14	4.83	4.76	4.78	5.05	4.90
P_2O_5	.11	.21	.15	.25	.32	.23	.31	.34	.22
H_2O+	1.63	1.35	1.28	1.28	1.61	1.08	1.65	1.19	1.00
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.47	99.93	99.60	99.62	100.32	100.15	100.11	100.06	101.83
Fe_2O_3t	1.19	1.96	.93	1.94	.98	1.27	.83	2.48	2.01
A/CNK	1.3	1.2	1.3	1.3	1.4	1.4	1.4	1.4	1.3
DI	90.8	90.4	91.9	90.0	92.9	91.6	91.2	88.5	93.0
Ba	276.	297.	237.	248.	183.	150.	267.	306.	285.
Rb	207.	201.	181.	301.	241.	277.	311.	290.	371.
Sr	93.	64.	43.	55.	43.	31.	40.	73.	43.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	69.0	91.0	52.0	128.0	105.0	281.0	167.0	128.0	130.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICA39 UNKN GRAN	ICA4 UNKN GRAN	ICA40 UNKN GRAN	ICA41 UNKN GRAN	ICA42 UNKN GRAN	ICA43 UNKN GRAN	ICA44 UNKN GRAN	ICA45 UNKN GRAN	ICA46 UNKN GRAN
SiO_2	74.06	72.96	74.72	74.60	73.03	73.09	70.74	73.49	72.11
TiO_2	.21	.36	.12	.13	.18	.09	.45	.16	.19
Al_2O_3	14.27	14.41	13.65	14.39	14.95	15.07	15.08	14.80	15.07
Fe_2O_3	.69	1.04	1.05	.93	.93	.61	1.47	.71	.85
FeO	.72	1.14	.24	.17	.15	.66	1.93	.78	.91
MnO	.03	.02	.04	.05	.04	.02	.04	.02	.02
MgO	.40	.71	.45	.30	.29	.25	.89	.59	.41
CaO	.49	1.01	.38	.52	.44	.50	.85	.63	.88
Na_2O	3.21	3.05	2.88	3.22	3.33	2.89	2.63	2.70	2.91
K_2O	5.04	4.87	4.63	4.27	4.90	5.25	4.95	5.17	5.31
P_2O_5	.29	.22	.33	.18	.18	.18	.26	.25	.10
H_2O+	.74	.86	1.69	1.33	1.78	1.61	.96	.81	1.39
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.15	100.65	100.18	100.09	100.20	100.22	100.25	100.11	100.15
Fe_2O_3t	1.49	2.31	1.32	1.12	1.10	1.34	3.61	1.58	1.86
A/CNK	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.2
DI	92.7	89.0	92.9	92.2	92.8	91.9	85.7	90.3	89.6
Ba	247.	324.	354.	299.	155.	226.	384.	217.	197.
Rb	202.	334.	344.	374.	288.	437.	369.	311.	159.
Sr	45.	101.	40.	50.	45.	48.	124.	76.	72.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	164.0	110.0	36.0	93.0	52.0	94.0	129.0	35.0	33.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICA47 UNKN GRAN	ICA48 UNKN GRAN	ICA5 UNKN GRAN	ICA6 UNKN GRAN	ICA7 UNKN GRAN	ICA8 UNKN GRAN	ICA9 UNKN GRAN	ICC025 UNKN GRAN	ICC114 UNKN GRAN
SiO_2	75.58	72.60	74.03	73.92	73.19	71.45	75.83	72.46	73.79
TiO_2	.04	.31	.09	.11	.17	.35	.02	.15	.18
Al_2O_3	13.60	14.88	14.72	14.29	14.29	14.70	13.63	14.97	12.69
Fe_2O_3	.39	.93	.41	.52	.60	.97	.41	.33	1.85
FeO	.44	.98	.44	.59	.68	1.06	.47	–	–
MnO	.09	.02	.02	.02	.02	.02	.02	.04	.01
MgO	.14	.39	.25	.34	.37	.70	.24	.25	.55
CaO	.65	.91	.72	.78	.73	.99	.70	.68	.95
Na_2O	2.80	3.21	3.75	3.41	2.98	2.73	3.46	3.35	4.31
K_2O	4.75	5.11	4.23	4.27	4.69	5.32	3.98	4.75	3.67
P_2O_5	.03	.12	.12	.08	.05	.09	.21	.40	.04
H_2O+	1.49	.89	1.12	1.31	1.56	1.36	1.61	1.42	1.70
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	100.00	100.35	99.90	99.64	99.33	99.74	100.58	98.80	99.74
Fe_2O_3t	.88	2.02	.90	1.17	1.35	2.15	.93	.33	1.85
A/CNK	1.2	1.2	1.2	1.2	1.3	1.2	1.2	1.3	1.0
DI	92.5	90.1	92.1	90.8	90.1	87.8	93.3	91.8	91.7
Ba	284.	341.	106.	179.	158.	352.	90.	286.	350.
Rb	141.	278.	397.	323.	290.	289.	271.	336.	174.
Sr	41.	49.	40.	73.	55.	86.	48.	106.	182.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	29.0	87.0	15.0	147.0	74.0	82.0	141.0	94.0	102.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICC141 UNKN GRAN	ICC142 UNKN GRAN	ICC144 UNKN GRAN	ICC146 UNKN GRAN	ICC164 UNKN GRAN	ICC166 UNKN GRAN	ICC167 UNKN GRAN	ICC169 UNKN GRAN	ICC170 UNKN GRAN
SiO_2	71.26	73.00	72.62	74.23	72.26	72.65	74.08	74.47	74.83
TiO_2	.36	.18	.28	.20	.26	.25	.22	.22	.18
Al_2O_3	15.47	14.75	15.16	16.51	15.38	14.80	14.80	14.54	14.95
Fe_2O_3	2.36	2.00	1.57	1.59	2.17	2.31	1.08	1.04	1.02
FeO	-	-	-	-	-	-	-	-	-
MnO	.05	.03	.03	.03	.03	.04	.02	.03	.05
MgO	.56	.32	.30	.27	.56	.60	.26	.28	.20
CaO	.82	.49	.54	.33	.48	.48	.39	.41	.49
Na_2O	2.45	2.27	2.51	1.68	2.47	2.39	2.48	2.89	3.43
K_2O	4.69	5.66	5.23	2.93	4.48	4.39	5.33	4.78	4.46
P_2O_5	.13	.13	.12	.01	.16	.21	.11	.06	.08
H_2O+	1.25	1.33	1.51	1.86	1.23	1.67	1.17	1.30	.54
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.40	100.16	99.87	99.64	99.48	99.79	99.94	100.02	100.23
Fe_2O_3t	2.36	2.00	1.57	1.59	2.17	2.31	1.08	1.04	1.02
A/CNK	1.5	1.4	1.4	2.5	1.6	1.6	1.4	1.4	1.3
DI	86.4	90.8	90.2	85.3	87.8	88.3	91.9	92.1	92.6
Ba	-	-	-	-	-	-	-	-	-
Rb	-	-	-	-	-	-	-	-	-
Sr	-	-	-	-	-	-	-	-	-
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICC172 UNKN GRAN	ICC173 UNKN GRAN	ICC174 UNKN GRAN	ICC175 UNKN GRAN	ICC190 UNKN GRAN	ICC191 UNKN GRAN	ICC199 UNKN GRAN	ICC200 UNKN GRAN	ICC201 UNKN GRAN
SiO_2	75.55	72.94	73.75	74.00	73.12	72.35	72.05	73.16	74.26
TiO_2	.11	.27	.15	.18	.20	.25	.33	.24	.13
Al_2O_3	13.75	14.66	15.49	13.69	15.42	15.03	15.32	14.75	14.64
Fe_2O_3	1.10	1.40	1.25	1.55	1.25	1.99	1.96	1.33	1.04
FeO	-	-	-	-	-	-	-	-	-
MnO	.04	.05	.04	.04	.04	.03	.01	.05	.03
MgO	.40	.34	.26	.37	.24	.29	.36	.31	.22
CaO	.42	.21	.59	.72	.49	.40	.37	.38	.40
Na_2O	2.48	2.08	3.42	3.27	2.28	2.08	2.46	2.06	2.84
K_2O	4.71	5.66	4.23	4.32	5.41	5.90	5.74	5.91	4.64
P_2O_5	.05	.09	.02	.08	.11	.09	.13	.11	.11
H_2O+	1.39	1.84	1.23	1.45	1.05	1.41	1.01	1.42	1.36
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.00	99.54	100.43	99.67	99.61	99.82	99.74	99.72	99.67
Fe_2O_3t	1.10	1.40	1.25	1.55	1.25	1.99	1.96	1.33	1.04
A/CNK	1.4	1.5	1.4	1.2	1.5	1.4	1.4	1.4	1.4
DI	91.8	91.2	91.1	91.1	90.3	90.4	90.5	91.2	91.8
Ba	-	-	-	-	-	-	-	-	-
Rb	-	-	-	-	-	-	-	-	-
Sr	-	-	-	-	-	-	-	-	-
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICC202 UNKN GRAN	ICC203 UNKN GRAN	ICC206 UNKN GRAN	ICC208 UNKN GRAN	ICC219 UNKN GRAN	ICC224 UNKN GRAN	ICC308 UNKN GRAN	ICC309 UNKN GRAN	ICC311 UNKN GRAN
SiO_2	73.41	74.75	73.46	73.83	72.66	74.03	73.02	73.82	74.20
TiO_2	.37	.12	.11	.09	.49	.16	.25	.14	.09
Al_2O_3	14.00	14.88	14.13	13.96	15.04	14.59	14.56	14.62	14.13
Fe_2O_3	1.93	1.24	1.78	1.82	2.09	1.77	.46	1.84	1.61
FeO	–	–	–	–	–	–	.87	–	–
MnO	.02	.02	.02	.02	.02	.01	.04	.01	.02
MgO	.42	.18	.31	.28	.31	.22	.39	.38	.30
CaO	.31	.67	.52	.58	.89	.59	.92	.51	.51
Na_2O	1.51	2.78	2.89	2.92	3.36	2.80	3.45	3.16	2.83
K_2O	6.03	4.95	5.09	4.88	3.57	5.13	4.65	4.77	4.90
P_2O_5	.13	.01	.07	.04	.12	.01	.27	.03	.06
H_2O+	1.65	.22	1.30	1.29	1.23	.41	1.00	.38	1.41
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.78	99.82	99.68	99.71	99.78	99.72	99.88	99.66	100.06
Fe_2O_3t	1.93	1.24	1.78	1.82	2.09	1.77	1.43	1.84	1.61
A/CNK	1.5	1.3	1.3	1.3	1.4	1.3	1.2	1.3	1.3
DI	90.5	90.9	91.5	91.3	88.0	90.9	90.6	90.9	91.8
Ba	–	–	222.	232.	–	–	350.	–	303.
Rb	–	–	439.	435.	–	–	320.	–	322.
Sr	–	–	55.	39.	–	–	86.	–	84.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	142.0	113.0	–	–	119.0	–	87.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICC318 UNKN GRAN	ICC327 UNKN GRAN	ICC332 UNKN GRAN	ICC348 UNKN GRAN	ICC357 UNKN GRAN	ICC363 UNKN GRAN	ICC366 UNKN GRAN	ICC408 UNKN GRAN	ICC418 UNKN GRAN
SiO_2	74.49	72.58	74.02	75.00	72.75	73.20	71.69	73.81	71.63
TiO_2	.08	.24	.24	.20	.12	.15	.33	.23	.34
Al_2O_3	14.47	14.84	12.78	12.64	13.86	14.99	15.16	12.68	14.54
Fe_2O_3	1.56	1.54	2.01	1.61	1.85	1.97	1.83	1.85	2.28
FeO	–	–	–	–	–	–	–	–	–
MnO	.02	.04	.01	.01	–	.02	.01	.01	.01
MgO	.11	.39	.46	.32	.30	.39	.23	.53	.75
CaO	.48	.41	.73	.54	.73	.54	.44	.73	.68
Na_2O	4.41	3.48	2.40	2.64	3.17	2.98	3.03	3.34	3.34
K_2O	2.69	4.74	4.91	5.27	5.54	5.00	5.80	4.58	4.19
P_2O_5	.05	.01	.15	.06	.12	.06	.08	.17	.05
H_2O+	1.37	2.07	2.44	1.32	1.02	.48	1.11	1.53	1.82
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.73	100.34	100.15	99.61	99.46	99.78	99.71	99.46	99.63
Fe_2O_3t	1.56	1.54	2.01	1.61	1.85	1.97	1.83	1.85	2.28
A/CNK	1.3	1.3	1.2	1.2	1.1	1.3	1.3	1.1	1.3
DI	92.0	92.1	91.0	92.7	91.9	90.4	91.7	91.7	88.4
Ba	–	352.	–	228.	338.	–	–	236.	311.
Rb	–	300.	–	301.	480.	–	–	286.	297.
Sr	–	20.	–	53.	52.	–	–	91.	88.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	71.0	–	75.0	152.0	–	–	111.0	82.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICC419 UNKN GRAN	ICC420 UNKN GRAN	ICC421 UNKN GRAN	ICC429 UNKN GRAN	ICC437 UNKN GRAN	ICC438 UNKN GRAN	ICC482 UNKN GRAN	ICC546 UNKN GRAN	ICC552 UNKN GRAN
SiO_2	75.12	71.80	74.08	74.36	73.39	74.19	72.82	73.27	73.30
TiO_2	.21	.27	.24	.24	.30	.11	.29	.40	.04
Al_2O_3	12.67	14.82	13.83	13.05	15.18	13.96	13.83	13.67	13.54
Fe_2O_3	1.77	1.70	1.20	1.29	1.83	2.05	2.15	2.05	1.83
FeO	–	–	–	–	–	–	–	–	–
MnO	.01	.01	.03	.04	.04	.02	.01	.01	.01
MgO	.31	.44	.11	.08	.56	.34	.46	.52	.31
CaO	.41	1.18	.53	.72	.72	.78	.42	.45	.41
Na_2O	2.88	2.28	2.97	3.39	3.37	2.76	2.83	2.33	3.53
K_2O	4.76	5.29	5.28	4.70	3.81	5.67	5.34	5.40	4.95
P_2O_5	.07	.03	.01	.04	.02	.05	.09	.17	.13
H_2O+	1.37	1.80	2.10	1.93	1.45	.69	1.49	1.34	1.49
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.58	99.62	100.38	99.84	100.67	100.62	99.73	99.61	99.54
Fe_2O_3t	1.77	1.70	1.20	1.29	1.83	2.05	2.15	2.05	1.83
A/CNK	1.2	1.3	1.2	1.1	1.4	1.2	1.2	1.3	1.1
DI	92.8	87.3	93.6	93.4	89.2	91.9	91.5	90.6	93.4
Ba	342.	299.	314.	214.	310.	–	–	–	–
Rb	391.	303.	307.	321.	253.	–	–	–	–
Sr	70.	54.	92.	64.	77.	–	–	–	–
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	150.0	71.0	90.0	107.0	81.0	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ICC554 UNKN GRAN	IGA071 UNKN GRAN	IGA187 UNKN GRAN	IGA188 UNKN GRAN	IGA189 UNKN GRAN	IGA204 UNKN GRAN	IGA205 UNKN GRAN	IGA231 UNKN GRAN	IGA232 UNKN GRAN
SiO_2	73.76	75.25	75.25	73.25	73.25	75.80	74.25	71.83	72.59
TiO_2	.23	.33	.22	.21	.39	.23	.22	.33	.24
Al_2O_3	13.58	14.36	14.51	14.82	14.36	14.39	14.15	14.78	14.54
Fe_2O_3	2.04	.55	.35	.32	.17	.52	.39	.50	.57
FeO	–	.69	.59	.51	.86	.44	.59	.94	.83
MnO	.01	.03	.03	.03	.03	.03	.03	.02	.03
MgO	.38	.28	.04	.04	.40	.07	.10	.45	.39
CaO	.33	.63	.43	.54	.80	.48	.60	.78	.74
Na_2O	2.16	3.33	3.27	4.17	2.98	2.91	3.98	3.21	3.17
K_2O	5.40	3.44	4.22	3.95	5.66	4.27	4.17	5.33	5.04
P_2O_5	.12	.30	.39	.48	.25	.48	.43	.38	.32
H_2O+	1.59	.47	.44	1.97	.54	.23	.98	1.30	1.39
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.60	99.66	99.74	100.29	99.69	99.85	99.89	99.85	99.85
Fe_2O_3t	2.04	1.32	1.00	.89	1.12	1.01	1.04	1.54	1.49
A/CNK	1.4	1.4	1.4	1.2	1.2	1.4	1.2	1.2	1.2
DI	91.2	90.6	92.8	94.1	91.4	92.5	94.0	91.0	91.1
Ba	–	289.	162.	4.	300.	35.	74.	354.	340.
Rb	–	981.	683.	404.	327.	410.	641.	446.	399.
Sr	–	40.	17.	17.	44.	23.	25.	87.	79.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	136.0	480.0	218.0	68.0	199.0	230.0	217.0	180.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	IGA233 UNKN GRAN	IGA234 UNKN GRAN	IGA235 UNKN GRAN	IGA238 UNKN GRAN	IGA247 UNKN GRAN	IGA248 UNKN GRAN	IGA250 UNKN GRAN	IGA251 UNKN GRAN	IGA275 UNKN GRAN
SiO_2	73.43	71.18	72.71	73.68	72.76	72.06	75.11	71.98	73.16
TiO_2	.25	.31	.41	.15	.36	.41	.04	.28	.19
Al_2O_3	14.39	14.39	14.70	14.05	14.44	14.39	14.54	14.70	14.85
Fe_2O_3	.74	.64	.53	.54	.46	.63	.13	.31	.60
FeO	.56	.95	1.02	.44	1.12	.87	.47	.59	.92
MnO	.02	.02	.02	.02	.02	.02	.07	.01	.02
MgO	.36	.78	.50	.32	.52	.52	.10	.53	.40
CaO	.68	.87	.74	.60	.78	.74	.41	1.01	.48
Na_2O	3.31	3.00	2.87	3.35	2.63	2.83	4.23	3.80	2.98
K_2O	4.89	5.19	5.11	4.62	5.20	5.41	3.44	4.49	4.84
P_2O_5	.31	.39	.37	.34	.33	.33	.86	.16	.11
H_2O+	1.06	1.61	.89	2.01	.99	1.40	.69	1.70	1.29
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	100.00	99.33	99.87	100.12	99.61	99.61	100.09	99.56	99.84
Fe_2O_3t	1.36	1.69	1.66	1.03	1.70	1.60	.65	.96	1.62
A/CNK	1.2	1.2	1.3	1.2	1.3	1.2	1.3	1.1	1.4
DI	92.2	89.1	90.1	93.2	89.4	90.5	93.6	90.2	90.5
Ba	276.	373.	275.	429.	100.	261.	64.	224.	214.
Rb	405.	368.	364.	375.	311.	328.	922.	291.	427.
Sr	64.	92.	100.	82.	90.	97.	67.	149.	48.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	165.0	147.0	175.0	194.0	140.0	128.0	491.0	208.0	155.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IGA279 UNKN GRAN	IGA306 UNKN GRAN	IGA315 UNKN GRAN	IGA324 UNKN GRAN	IGA325 UNKN GRAN	IGA326 UNKN GRAN	ILC1 UNKN GRAN	ILC2 UNKN GRAN	ILC3 UNKN GRAN
SiO_2	71.81	70.91	73.62	72.06	72.55	72.36	70.04	67.94	70.20
TiO_2	.17	.31	.30	.26	.37	.30	.70	.62	.59
Al_2O_3	15.65	14.96	13.84	15.42	15.12	15.03	13.01	14.68	13.70
Fe_2O_3	.41	.61	.73	.45	.62	.52	4.83	4.31	3.78
FeO	1.03	1.19	1.03	.76	1.04	1.21	–	–	–
MnO	.03	.04	.03	.03	.02	.03	.07	.05	.05
MgO	.40	.59	.46	.28	.38	.35	.91	.84	.82
CaO	.62	.99	.92	.76	.82	.91	1.89	1.99	1.62
Na_2O	3.06	3.10	2.75	3.63	3.37	2.97	2.96	3.40	3.22
K_2O	4.93	4.82	4.88	4.34	4.59	4.91	4.57	5.30	5.10
P_2O_5	.18	.26	.22	.27	.27	.25	.22	.22	.21
H_2O+	1.42	1.50	.99	1.20	.72	.99	.64	.60	.48
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.71	99.28	99.77	99.46	99.87	99.83	99.84	99.95	99.77
Fe_2O_3t	1.55	1.93	1.87	1.29	1.77	1.86	4.83	4.31	3.78
A/CNK	1.4	1.2	1.2	1.3	1.3	1.3	1.0	1.0	1.0
DI	89.4	87.6	89.5	90.2	89.7	88.9	83.1	83.6	85.6
Ba	251.	357.	679.	312.	275.	262.	320.	550.	340.
Rb	386.	460.	221.	335.	328.	380.	230.	230.	240.
Sr	52.	90.	67.	49.	36.	27.	90.	120.	90.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	104.0	149.0	93.0	170.0	167.0	161.0	180.0	150.0	190.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ILC4 UNKN GRAN	ILC5 UNKN GRAN	IMB172 UNKN GRAN	IMB176 UNKN GRAN	IMB181 UNKN GRAN	IMC053 UNKN GRAN	IMC059 UNKN GRAN	IMC060 UNKN GRAN	IMC293 UNKN GRAN
SiO_2	73.70	69.30	75.28	75.72	73.58	70.54	69.65	73.29	71.87
TiO_2	.31	.65	.20	.18	.33	.47	.47	.02	.02
Al_2O_3	12.84	13.20	14.05	13.97	14.44	15.71	15.67	14.45	14.96
Fe_2O_3	2.32	4.37	.28	.29	.54	.40	.23	.35	.42
FeO	-	-	.44	.50	.98	1.45	2.01	1.38	1.05
MnO	.04	.06	.10	.03	.05	.03	.03	.02	.02
MgO	.46	.89	.02	.01	.31	.65	.80	.48	.44
CaO	1.12	1.92	.41	.45	.90	1.02	1.38	.85	.67
Na_2O	3.20	3.47	4.13	4.06	3.76	3.20	3.49	3.41	3.30
K_2O	5.08	5.06	4.22	3.84	4.27	5.29	4.73	5.05	4.82
P_2O_5	.13	.25	.33	.25	.33	.09	.16	.22	.20
H_2O+	.59	.59	.24	.44	.32	.80	1.09	.42	1.59
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.79	99.76	99.70	99.74	99.81	99.65	99.71	99.94	99.36
Fe_2O_3t	2.32	4.37	.77	.85	1.63	2.01	2.46	1.88	1.59
A/CNK	1.0	.9	1.2	1.2	1.2	1.2	1.2	1.1	1.3
DI	90.6	85.4	95.0	94.4	90.8	87.1	84.7	90.3	89.8
Ba	180.	450.	35.	35.	408.	497.	538.	457.	286.
Rb	250.	230.	787.	683.	286.	144.	218.	255.	302.
Sr	60.	110.	13.	15.	57.	89.	122.	79.	76.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	180.0	180.0	197.0	192.0	239.0	94.0	84.0	128.0	103.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IMC294 UNKN GRAN	IMC295 UNKN GRAN	IMC296 UNKN GRAN	IMC301 UNKN GRAN	IMC303 UNKN GRAN	IMC304 UNKN GRAN	IMC305 UNKN GRAN	IMM1 UNKN GRAN	IMM10 UNKN GRAN
SiO_2	72.78	75.71	70.87	72.00	72.81	71.06	74.34	75.30	74.10
TiO_2	.16	.02	.21	.25	.04	.07	.07	.07	.07
Al_2O_3	14.36	13.63	16.14	14.60	14.78	14.96	14.03	14.25	14.65
Fe_2O_3	.53	.16	.39	.57	.35	.47	.37	.40	1.00
FeO	1.04	.38	1.08	1.00	.90	1.00	.39	–	–
MnO	.02	.03	.03	.05	.04	.04	.02	.09	.08
MgO	.48	.10	.53	.47	.35	.48	.17	.12	.27
CaO	.64	.30	.70	.51	.51	1.10	.46	.14	.17
Na_2O	3.20	3.85	3.26	3.16	3.50	3.62	3.44	4.60	3.05
K_2O	4.77	3.84	5.08	5.04	4.42	4.13	4.56	3.68	5.36
P_2O_5	.24	.20	.31	.28	.31	.22	.27	–	–
H_2O+	1.52	1.81	1.19	1.66	1.55	1.16	1.39	.04	.06
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.74	100.03	99.79	99.59	99.56	98.31	99.51	98.69	98.81
Fe_2O_3t	1.68	.58	1.59	1.68	1.35	1.58	.80	.40	1.00
A/CNK	1.2	1.2	1.3	1.3	1.3	1.2	1.2	1.2	1.3
DI	90.6	95.1	89.1	90.9	91.3	87.2	93.6	94.7	92.6
Ba	222.	72.	439.	346.	394.	581.	143.	140.	40.
Rb	328.	276.	324.	316.	309.	309.	379.	273.	455.
Sr	81.	43.	124.	90.	100.	190.	57.	34.	42.
Y	–	–	–	–	–	–	–	10.	10.
Zr	–	–	–	–	–	–	–	30.	25.
Nb	–	–	–	–	–	–	–	25.	10.
Th	–	–	–	–	–	–	–	20.00	20.00
Pb	–	–	–	–	–	–	–	32.	30.
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	22.0	55.0
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	50.0	35.0
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	67.0	227.0	196.0	112.0	140.0	182.0	90.0	5.0	13.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	97.0	40.0
Mo	–	–	–	–	–	–	–	10.00	11.00
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	IMM11 UNKN GRAN	IMM12 UNKN GRAN	IMM13 UNKN GRAN	IMM14 UNKN GRAN	IMM15 UNKN GRAN	IMM16 UNKN GRAN	IMM17 UNKN GRAN	IMM18 UNKN GRAN	IMM19 UNKN GRAN
SiO_2	73.90	72.10	73.00	73.35	74.90	71.95	73.85	61.20	58.80
TiO_2	.03	.03	.03	.11	.03	.14	.07	.90	.06
Al_2O_3	14.25	14.80	14.80	15.80	15.30	15.80	15.70	18.40	20.50
Fe_2O_3	.70	1.10	.90	.85	.70	1.10	.40	6.50	6.30
FeO	-	-	-	-	-	-	-	-	-
MnO	.09	.20	.41	.10	.08	.04	.05	.07	.06
MgO	.17	.31	.25	.23	.21	.28	.13	3.25	3.40
CaO	.34	.34	.20	.42	.42	.44	.39	.75	.43
Na_2O	5.60	4.80	6.80	3.48	4.65	3.52	5.60	.82	.50
K_2O	2.58	4.76	2.18	4.15	3.92	4.65	2.06	3.65	4.23
P_2O_5	-	-	-	-	-	-	-	.25	.15
H_2O+	.05	.04	.03	.02	.04	.02	.06	4.23	4.76
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	97.71	98.48	98.60	98.51	100.25	97.94	98.31	100.02	99.19
Fe_2O_3t	.70	1.10	.90	.85	.70	1.10	.40	6.50	6.30
A/CNK	1.1	1.1	1.1	1.4	1.2	1.4	1.3	2.8	3.3
DI	93.1	93.6	94.8	90.0	94.2	89.6	92.0	68.1	66.6
Ba	25.	25.	40.	25.	110.	75.	70.	750.	740.
Rb	195.	380.	215.	320.	272.	312.	282.	170.	170.
Sr	28.	22.	47.	34.	51.	28.	70.	125.	50.
Y	10.	10.	10.	10.	10.	10.	10.	24.	25.
Zr	48.	30.	60.	27.	25.	40.	45.	158.	160.
Nb	10.	10.	18.	10.	10.	13.	35.	18.	10.
Th	30.00	20.00	30.00	20.00	20.00	20.00	20.00	23.00	20.00
Pb	36.	30.	28.	28.	28.	40.	32.	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	44.0	44.0	19.0	52.0	33.0	55.0	22.0	116.0	125.0
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	50.0	85.0	80.0	60.0	60.0	25.0	60.0	50.0	43.0
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	7.0	7.0	7.0	7.0	6.0	19.0	4.0	110.0	90.0
Be	-	-	-	-	-	-	-	3.0	4.0
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	10.0	10.0	48.0	10.0	10.0	10.0	125.0	10.0	10.0
Mo	13.00	11.00	11.00	10.00	13.00	10.00	10.00	5.00	5.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IMM2 UNKN GRAN	IMM20 UNKN GRAN	IMM21 UNKN GRAN	IMM22 UNKN GRAN	IMM23 UNKN GRAN	IMM24 UNKN GRAN	IMM25 UNKN GRAN	IMM3 UNKN GRAN	IMM4 UNKN GRAN
SiO_2	72.85	62.90	59.70	59.20	60.50	58.60	62.50	73.60	75.00
TiO_2	.07	1.10	.80	1.10	.85	.80	.75	.05	.03
Al_2O_3	14.75	17.10	19.30	17.50	16.90	20.30	17.50	14.75	14.25
Fe_2O_3	.70	6.20	6.30	7.20	6.90	6.30	5.80	.50	.50
FeO	-	-	-	-	-	-	-	-	-
MnO	.02	.04	.06	.08	.09	.07	.10	.09	.04
MgO	.27	3.00	3.21	3.76	3.45	3.25	2.16	.12	.20
CaO	.32	.34	.45	.69	.81	.45	.60	.17	.46
Na_2O	5.40	.33	.34	.20	.92	.33	.24	6.50	5.00
K_2O	3.30	4.34	4.22	3.40	4.32	4.33	5.20	1.73	3.68
P_2O_5	-	.10	.80	.24	.18	.10	.15	-	-
H_2O+	.02	4.56	5.49	6.03	5.05	5.25	4.98	.03	.05
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	97.70	100.01	100.67	99.40	99.97	99.78	99.98	97.54	99.21
Fe_2O_3t	.70	6.20	6.30	7.20	6.90	6.30	5.80	.50	.50
A/CNK	1.1	2.9	3.3	3.3	2.2	3.4	2.5	1.2	1.1
DI	92.9	71.1	68.3	64.3	69.1	66.5	73.6	93.9	94.7
Ba	240.	690.	740.	400.	850.	750.	750.	25.	25.
Rb	165.	250.	150.	150.	165.	42.	85.	205.	305.
Sr	112.	30.	60.	42.	98.	20.	30.	25.	53.
Y	10.	26.	26.	18.	20.	152.	160.	10.	10.
Zr	25.	178.	150.	175.	150.	16.	14.	50.	25.
Nb	10.	12.	16.	18.	10.	10.	10.	18.	10.
Th	25.00	20.00	24.00	20.00	20.00	20.00	23.00	25.00	20.00
Pb	34.	-	-	-	-	-	340.	28.	30.
Ga	-	-	-	-	-	-	-	-	-
Zn	29.0	96.0	131.0	160.0	160.0	124.0	200.0	44.0	44.0
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	35.0	-	-	-	-	-	-	70.0	30.0
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	6.0	120.0	95.0	130.0	140.0	190.0	78.0	3.0	4.0
Be	-	3.0	4.0	5.0	3.0	4.0	6.0	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	10.0	10.0	10.0	10.0	10.0	45.0	-	65.0	10.0
Mo	13.00	-	-	-	-	-	-	11.00	10.00
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IMM5 UNKN GRAN	IMM6 UNKN GRAN	IMM7 UNKN GRAN	IMM8 UNKN GRAN	IMM9 UNKN GRAN	IOC241 UNKN GRAN	IOC256 UNKN GRAN	IOC257 UNKN GRAN	IOC259 UNKN GRAN
SiO_2	75.10	75.10	75.10	75.35	74.30	72.75	73.03	72.37	72.80
TiO_2	.03	.03	.03	.03	.03	.23	.32	.33	.30
Al_2O_3	14.25	13.75	14.00	14.00	14.25	14.81	14.70	14.64	14.54
Fe_2O_3	.60	.50	.90	.50	.85	.47	.52	.36	.48
FeO	–	–	–	–	–	.50	.76	.99	.79
MnO	.10	.02	.09	.07	.08	.01	.02	.01	.02
MgO	.16	.16	.13	.14	.13	.31	.41	.43	.45
CaO	.44	.36	.22	.28	.30	.62	.58	.81	.68
Na_2O	5.15	4.95	4.90	4.65	5.75	3.37	2.77	3.12	3.44
K_2O	2.23	3.68	2.73	3.46	3.28	5.13	5.30	5.19	4.93
P_2O_5	–	–	–	–	–	.36	.31	.33	.31
H_2O+	.04	.05	.04	.05	.06	1.36	1.00	1.26	1.05
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	98.10	98.60	98.14	98.53	99.03	99.92	99.72	99.84	99.79
Fe_2O_3t	.60	.50	.90	.50	.85	1.03	1.36	1.46	1.36
A/CNK	1.2	1.1	1.2	1.2	1.1	1.2	1.3	1.2	1.2
DI	92.2	94.9	93.1	94.1	95.6	92.8	91.1	90.7	91.6
Ba	70.	30.	40.	30.	60.	369.	280.	233.	250.
Rb	183.	280.	268.	257.	323.	395.	551.	456.	412.
Sr	62.	40.	15.	31.	28.	36.	126.	221.	215.
Y	10.	10.	10.	10.	10.	–	–	–	–
Zr	27.	25.	35.	47.	25.	–	–	–	–
Nb	12.	10.	12.	10.	22.	–	–	–	–
Th	20.00	20.00	20.00	25.00	25.00	–	–	–	–
Pb	32.	34.	34.	32.	32.	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	37.0	70.0	59.0	40.0	40.0	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	85.0	70.0	80.0	30.0	40.0	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	8.0	12.0	5.0	6.0	5.0	268.0	294.0	184.0	141.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	10.0	10.0	10.0	10.0	10.0	–	–	–	–
Mo	11.00	10.00	15.00	15.00	12.00	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	IOC262 UNKN GRAN	IOC263 UNKN GRAN	IOC264 UNKN GRAN	IOC267 UNKN GRAN	IOC269 UNKN GRAN	IOC309 UNKN GRAN	IOC310 UNKN GRAN	IOC311 UNKN GRAN	ITR1 UNKN GRAN
SiO_2	73.11	71.39	72.81	73.17	71.92	78.13	75.00	73.16	71.53
TiO_2	.18	.29	.21	.26	.24	.08	.15	.32	.22
Al_2O_3	14.70	15.30	15.00	14.23	15.15	12.25	14.39	14.67	15.93
Fe_2O_3	.62	.80	.32	.54	.47	.11	.25	.53	1.81
FeO	.34	1.16	.76	.80	.50	.16	.36	.86	–
MnO	.03	.03	.02	.03	.01	.04	.04	.19	.03
MgO	.55	.73	.38	.55	.43	.11	.18	.44	.42
CaO	1.64	1.45	.72	1.04	.70	.55	.62	.76	.68
Na_2O	4.60	4.45	3.34	3.97	3.38	3.67	3.89	2.80	3.81
K_2O	2.93	3.13	5.04	3.91	5.41	3.99	4.46	4.74	4.68
P_2O_5	.18	.16	.43	.19	.42	.09	.35	.35	.14
H_2O+	.76	1.13	1.11	.99	1.32	.85	.12	1.09	1.14
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.64	100.02	100.14	99.68	99.95	100.03	99.81	99.91	100.39
Fe_2O_3t	1.00	2.09	1.16	1.43	1.03	.29	.65	1.48	1.81
A/CNK	1.1	1.2	1.2	1.1	1.2	1.1	1.2	1.3	1.3
DI	88.2	86.4	91.9	89.9	92.3	95.8	94.0	89.7	90.7
Ba	400.	630.	224.	875.	294.	400.	315.	288.	186.
Rb	152.	186.	351.	253.	419.	313.	289.	386.	382.
Sr	428.	310.	46.	123.	67.	86.	57.	36.	40.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	44.
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	54.0
Cu	–	–	–	–	–	–	–	–	3.0
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	135.0	151.0	148.0	282.0	68.0	209.0	279.0	163.0	270.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ITR10 UNKN GRAN	ITR11 UNKN GRAN	ITR12 UNKN GRAN	ITR13 UNKN GRAN	ITR14 UNKN GRAN	ITR15 UNKN GRAN	ITR16 UNKN GRAN	ITR17 UNKN GRAN	ITR18 UNKN GRAN
SiO_2	73.26	72.58	74.32	74.32	72.39	72.68	72.68	72.69	73.46
TiO_2	.19	.12	.09	.13	.14	.17	.21	.19	.21
Al_2O_3	14.51	15.23	14.36	14.06	14.60	14.36	14.64	14.40	14.14
Fe_2O_3	1.25	1.20	.23	1.23	1.34	1.45	1.39	1.58	1.39
FeO	–	–	–	–	–	–	–	–	–
MnO	.02	.02	.01	.02	.01	.01	.02	.02	.02
MgO	.35	.25	.16	.31	.42	.39	.35	.34	.35
CaO	.52	.51	.41	.66	.51	.50	.62	.58	.56
Na_2O	3.75	3.89	3.77	4.44	3.88	3.85	3.95	3.91	3.79
K_2O	4.38	4.32	4.27	3.96	4.86	4.81	4.26	4.55	4.57
P_2O_5	.12	.14	.09	.16	.13	.10	.17	.10	.12
H_2O+	1.38	1.32	1.44	.70	1.35	1.35	1.23	1.34	1.43
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.73	99.58	99.15	99.99	99.63	99.67	99.52	99.70	100.04
Fe_2O_3t	1.25	1.20	.23	1.23	1.34	1.45	1.39	1.58	1.39
A/CNK	1.2	1.3	1.2	1.1	1.2	1.2	1.2	1.2	1.2
DI	92.3	92.0	93.7	93.5	92.7	92.8	91.8	92.3	92.9
Ba	151.	172.	103.	242.	194.	203.	133.	156.	174.
Rb	388.	334.	336.	283.	265.	337.	266.	317.	219.
Sr	34.	39.	28.	60.	40.	33.	31.	32.	37.
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	49.	46.	31.	27.	57.	41.	43.	37.	56.
Ga	–	–	–	–	–	–	–	–	–
Zn	67.0	69.0	41.0	38.0	58.0	41.0	61.0	70.0	66.0
Cu	3.0	7.0	3.0	3.0	1.0	4.0	1.0	1.0	1.0
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	337.0	286.0	290.0	196.0	170.0	295.0	195.0	289.0	272.0
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

IBERIA

	ITR19 UNKN GRAN	ITR2 UNKN GRAN	ITR3 UNKN GRAN	ITR4 UNKN GRAN	ITR5 UNKN GRAN	ITR6 UNKN GRAN	ITR7 UNKN GRAN	ITR8 UNKN GRAN	ITR9 UNKN GRAN
SiO_2	72.36	72.67	72.31	72.15	72.01	73.62	73.18	73.91	73.33
TiO_2	.21	.30	.24	.21	.19	.18	.19	.08	.10
Al_2O_3	15.21	14.49	14.66	14.95	15.12	13.93	14.81	15.33	14.21
Fe_2O_3	1.82	1.91	1.51	1.26	1.42	1.39	1.48	.85	1.38
FeO	-	-	-	-	-	-	-	-	-
MnO	.04	.04	.02	.03	.03	.02	.02	.02	.01
MgO	.38	.44	.38	.35	.31	.31	.37	.16	.38
CaO	.45	.80	.38	.73	.68	.54	.56	.53	.74
Na_2O	2.44	3.86	3.58	3.76	3.88	3.81	3.64	4.08	3.81
K_2O	5.37	4.72	4.70	4.51	4.56	4.59	4.16	3.98	4.34
P_2O_5	.12	.09	.13	.16	.08	.12	.11	.09	.18
H_2O+	1.51	1.06	1.36	1.73	1.46	1.36	1.23	1.28	1.19
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.91	100.38	99.27	99.84	99.74	99.87	99.75	100.31	99.67
Fe_2O_3t	1.82	1.91	1.51	1.26	1.42	1.39	1.48	.85	1.38
A/CNK	1.4	1.1	1.3	1.2	1.2	1.1	1.3	1.3	1.2
DI	90.2	91.6	91.8	91.4	91.4	93.2	91.2	93.1	91.9
Ba	141.	130.	129.	124.	175.	211.	217.	46.	189.
Rb	279.	302.	412.	319.	392.	342.	379.	513.	388.
Sr	39.	209.	102.	34.	35.	37.	39.	40.	36.
Y	-	-	-	-	-	-	-	-	-
Zr	-	-	-	-	-	-	-	-	-
Nb	-	-	-	-	-	-	-	-	-
Th	-	-	-	-	-	-	-	-	-
Pb	51.	64.	61.	31.	40.	24.	17.	34.	27.
Ga	-	-	-	-	-	-	-	-	-
Zn	62.0	45.0	52.0	56.0	60.0	81.0	86.0	51.0	62.0
Cu	1.0	2.0	1.0	1.0	1.0	2.0	3.0	1.0	1.0
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	291.0	293.0	319.0	353.0	346.0	336.0	278.0	525.0	306.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

IBERIA

	IVA1 UNKN GRAN	IVA2 UNKN GRAN	IVA3 UNKN GRAN	IVA4 UNKN GRAN	IVA5 UNKN GRAN	IVA6 UNKN GRAN	IVA7 UNKN GRAN	IVA8 UNKN GRAN
SiO_2	68.38	71.25	71.58	72.15	72.50	72.80	74.10	74.49
TiO_2	.68	.66	.43	.42	.43	.40	.35	.31
Al_2O_3	15.40	14.30	13.30	14.80	14.40	14.00	13.30	13.30
Fe_2O_3	–	–	–	–	–	–	–	–
FeO	5.20	4.60	2.60	2.50	2.50	2.50	2.20	2.30
MnO	.05	.04	.03	.02	.02	.02	.03	.03
MgO	1.70	1.50	.69	.70	.60	.70	2.20	.49
CaO	.85	.90	.83	.92	.90	.54	.80	.66
Na_2O	3.70	3.30	3.60	3.70	3.70	3.60	3.70	3.70
K_2O	2.50	2.20	4.20	4.00	3.90	3.70	4.00	3.60
P_2O_5	.13	.25	.27	.33	.35	.27	.30	.28
H_2O+	1.94	1.50	.77	1.06	1.00	1.30	.84	1.00
H_2O-	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–
TOTAL	100.53	100.50	98.30	100.60	100.30	99.83	101.82	100.16
Fe_2O_3t	5.77	5.11	2.89	2.78	2.78	2.78	2.44	2.55
A/CNK	1.5	1.5	1.1	1.2	1.2	1.3	1.1	1.2
DI	77.0	78.9	86.6	87.3	87.7	87.9	87.2	89.6
Ba	485.	440.	340.	300.	280.	235.	225.	150.
Rb	149.	133.	301.	306.	331.	297.	308.	321.
Sr	110.	110.	68.	62.	57.	54.	51.	33.
Y	–	–	–	–	–	–	–	–
Zr	54.	62.	115.	114.	115.	125.	103.	108.
Nb	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–
Zn	53.0	49.0	50.0	46.0	60.0	30.0	44.0	46.0
Cu	33.0	23.0	9.0	10.0	9.0	12.0	7.0	11.0
Ni	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–
V	96.	78.	25.	24.	23.	24.	19.	19.
Cr	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–
Li	115.0	87.0	76.0	93.0	81.0	89.0	93.0	12.5
Be	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	ABB11 UNKN GRAN	ABB18 UNKN GRAN	ABB19 UNKN GRAN	ABB20 UNKN GRAN	ABB3 UNKN GRAN	ABB36 UNKN GRAN	ABB37 UNKN GRAN	ABB38 UNKN GRAN	ABB63 UNKN GRAN
SiO_2	70.89	67.37	67.62	67.03	67.71	65.86	67.50	68.07	68.79
TiO_2	.35	.58	.55	.59	.58	.62	.60	.48	.50
Al_2O_3	13.92	14.91	14.31	14.23	14.29	14.91	14.36	13.53	13.72
Fe_2O_3	.72	1.40	1.25	1.57	.84	.96	.78	.69	.81
FeO	2.26	2.88	3.06	3.23	3.75	4.36	3.77	3.65	3.35
MnO	.06	.07	.07	.08	.07	.09	.07	.07	.06
MgO	1.00	2.12	2.35	2.25	2.23	2.64	2.43	3.21	2.65
CaO	2.31	3.15	2.80	3.21	2.95	3.79	2.98	3.08	2.45
Na_2O	2.56	2.35	2.11	1.95	2.00	1.95	2.14	1.83	1.83
K_2O	3.96	3.32	3.59	3.40	3.41	3.07	3.40	3.27	3.39
P_2O_5	.09	.12	.13	.13	.14	.14	.12	.11	.10
H_2O+	1.39	1.39	1.43	1.56	1.48	1.39	1.45	1.44	1.83
H_2O-	.15	.37	.32	.31	.21	.13	.13	.18	.25
CO_2	.29	.14	.21	.14	.12	.09	.22	.21	.16
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.18	.18	.18	.18	.18	.18	.17	.18	.17
TOTAL	100.13	100.35	99.98	99.86	99.96	100.28	100.12	100.00	100.06
Fe_2O_3t	3.23	4.60	4.65	5.16	5.00	5.91	4.96	4.74	4.53
A/CNK	1.1	1.1	1.2	1.1	1.2	1.1	1.1	1.1	1.2
DI	79.8	70.8	71.2	69.1	69.7	63.8	69.4	67.4	71.2
Ba	625.	455.	485.	455.	470.	455.	465.	430.	460.
Rb	178.	169.	179.	173.	166.	151.	155.	162.	153.
Sr	198.	144.	130.	132.	134.	151.	133.	130.	119.
Y	40.	31.	28.	28.	29.	27.	28.	27.	29.
Zr	136.	179.	162.	171.	169.	155.	175.	127.	155.
Nb	11.	11.	11.	12.	11.	11.	12.	12.	11.
Th	18.00	18.60	17.40	17.60	17.80	15.00	17.80	16.80	19.60
Pb	33.	28.	26.	26.	25.	23.	25.	24.	28.
Ga	15.	17.	16.	17.	17.	17.	17.	15.	15.
Zn	47.0	70.0	65.0	77.0	72.0	81.0	64.0	59.0	50.0
Cu	6.0	11.5	16.0	13.0	16.0	8.0	14.5	37.0	12.0
Ni	5.5	17.0	18.0	17.5	20.5	18.0	19.0	32.5	25.5
TiO_2	-	-	-	-	-	-	-	-	-
V	42.	90.	83.	96.	89.	115.	89.	86.	76.
Cr	13.	55.	65.	57.	71.	69.	63.	148.	96.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	12.0	17.0	16.0	19.0	18.0	22.0	17.0	17.0	14.0
Ta	-	-	-	-	-	-	-	-	-
Co	8.	13.	14.	16.	17.	18.	15.	21.	15.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	4.20	3.20	4.20	3.60	2.40	2.60	3.00	3.60	3.80
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	31.	33.	31.	34.	33.	27.	23.	35.	33.
Ce	70.	71.	67.	71.	69.	65.	66.	62.	71.

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	ABB64 UNKN GRAN	ABB66 UNKN GRAN	ABB67 UNKN GRAN	ABB68 UNKN UNKN	ABB70 UNKN GRAN	ABB81 UNKN GRAN	ABB82 UNKN GRAN	ABB83 UNKN GRAN	ABB84 UNKN GRAN
SiO_2	65.81	68.81	69.45	71.09	67.37	67.22	67.52	67.82	68.07
TiO_2	.52	.51	.44	.40	.59	.64	.54	.61	.63
Al_2O_3	14.21	13.93	13.96	13.66	14.35	14.60	13.86	14.47	14.49
Fe_2O_3	1.22	1.19	1.13	.79	.84	.80	.61	.54	.58
FeO	3.62	2.71	2.24	2.28	3.67	3.73	4.02	4.09	3.82
MnO	.08	.06	.06	.06	.07	.07	.07	.07	.07
MgO	3.57	1.56	1.35	1.27	2.37	2.17	3.10	2.33	2.13
CaO	3.72	3.02	2.87	2.31	2.88	2.91	2.94	3.05	2.55
Na_2O	1.83	2.21	2.40	2.38	1.99	2.24	1.83	2.06	2.07
K_2O	3.08	3.65	3.69	4.25	3.64	3.34	3.13	3.40	3.30
P_2O_5	.11	.12	.12	.09	.13	.14	.13	.14	.15
H_2O+	1.57	1.56	1.64	1.13	1.57	1.50	1.56	1.13	1.41
H_2O-	.24	.21	.22	.16	.21	.26	.14	.19	.14
CO_2	.11	.09	.11	.07	.18	.10	.23	.18	.18
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.18	.17	.16	.17	.18	.17	.18	.18	.17
TOTAL	99.87	99.80	99.84	100.11	100.04	99.89	99.86	100.26	99.76
Fe_2O_3t	5.24	4.20	3.62	3.32	4.91	4.94	5.07	5.08	4.82
A/CNK	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.3
DI	63.1	73.7	76.0	79.4	69.9	69.9	66.8	69.0	70.9
Ba	415.	515.	450.	565.	550.	450.	420.	445.	455.
Rb	155.	176.	175.	207.	165.	168.	164.	169.	169.
Sr	134.	175.	170.	140.	135.	135.	130.	139.	129.
Y	27.	31.	33.	33.	28.	28.	28.	28.	28.
Zr	143.	158.	151.	148.	158.	173.	160.	174.	177.
Nb	10.	11.	11.	10.	11.	11.	11.	12.	12.
Th	15.60	18.60	18.60	20.00	19.40	18.00	17.40	17.20	18.20
Pb	21.	25.	27.	32.	17.	26.	21.	26.	25.
Ga	16.	16.	16.	15.	16.	17.	16.	17.	17.
Zn	68.0	56.0	52.0	44.0	47.0	74.0	64.0	70.0	71.0
Cu	16.5	6.0	5.0	2.5	15.0	11.5	8.0	15.5	11.0
Ni	35.0	8.5	7.5	6.5	19.5	16.5	29.0	19.5	17.5
TiO_2	-	-	-	-	-	-	-	-	-
V	102.	77.	61.	56.	89.	90.	90.	88.	88.
Cr	166.	28.	19.	27.	68.	45.	132.	65.	56.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	19.0	15.0	13.0	12.0	16.0	16.0	17.0	17.0	16.0
Ta	-	-	-	-	-	-	-	-	-
Co	21.	12.	16.	9.	11.	15.	18.	17.	15.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	3.40	2.00	2.60	4.60	4.00	3.20	3.00	3.80	2.80
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	30.	31.	31.	30.	33.	3.	31.	29.	31.
Ce	62.	72.	65.	70.	79.	70.	67.	64.	68.

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	ABB89 UNKN GRAN	ABB9 UNKN GRAN	ABB90 UNKN GRAN	ABB91 UNKN GRAN	ABB92 UNKN GRAN	ABB94 UNKN GRAN	ABB95 UNKN GRAN	ABB96 UNKN GRAN	AKB10 UNKN GRAN
SiO_2	68.65	68.21	67.64	67.96	68.86	68.36	69.20	68.33	71.86
TiO_2	.63	.53	.51	.53	.52	.56	.53	.54	.36
Al_2O_3	14.10	14.25	14.66	14.21	14.27	14.02	14.03	13.94	13.72
Fe_2O_3	1.18	.93	1.68	1.34	1.03	.85	.90	1.59	.71
FeO	3.29	3.10	2.24	2.79	3.06	3.34	2.99	2.48	2.02
MnO	.07	.07	.07	.06	.07	.07	.06	.07	.05
MgO	2.02	1.68	1.64	1.73	1.54	1.83	1.75	1.75	1.08
CaO	2.51	3.11	3.38	3.32	3.29	3.25	2.93	3.02	1.95
Na_2O	2.11	2.23	2.37	2.17	2.27	2.27	2.23	2.19	2.55
K_2O	3.45	3.77	3.52	3.42	3.44	3.50	3.79	3.67	4.11
P_2O_5	.14	.13	.12	.12	.12	.12	.11	.12	.12
H_2O+	1.55	1.28	1.34	1.66	1.10	1.17	1.18	1.67	.85
H_2O-	.30	.12	.36	.20	.15	.21	.13	.31	.20
CO_2	.04	.29	.08	.23	.14	.15	.11	.14	.08
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.18	.18	.18	.17	.19	.17	.18	.18	-
TOTAL	100.22	99.88	99.79	99.91	100.05	99.87	100.12	100.00	99.66
Fe_2O_3t	4.83	4.37	4.17	4.44	4.43	4.56	4.22	4.34	2.95
A/CNK	1.2	1.1	1.1	1.1	1.1	1.0	1.1	1.1	1.1
DI	72.9	72.5	72.3	71.5	72.2	71.3	73.6	73.5	81.4
Ba	470.	530.	510.	475.	570.	480.	500.	485.	425.
Rb	175.	179.	171.	163.	173.	153.	185.	180.	199.
Sr	140.	167.	184.	174.	190.	135.	156.	156.	103.
Y	31.	30.	30.	30.	33.	25.	32.	-	35.
Zr	187.	158.	157.	166.	171.	152.	175.	-	134.
Nb	12.	12.	11.	11.	13.	10.	12.	-	-
Th	19.20	15.80	18.00	17.00	19.80	14.80	18.80	-	16.80
Pb	25.	24.	24.	24.	23.	19.	24.	-	-
Ga	17.	16.	17.	16.	17.	14.	16.	-	-
Zn	70.0	57.0	59.0	56.0	56.0	55.0	65.0	-	44.0
Cu	14.0	11.0	4.0	12.0	3.0	5.5	6.0	-	5.0
Ni	17.5	9.5	9.5	7.5	8.5	9.0	10.5	-	7.5
TiO_2	-	-	-	-	-	-	-	-	-
V	84.	95.	83.	84.	81.	92.	90.	-	44.
Cr	50.	32.	31.	30.	27.	38.	36.	-	22.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	15.0	18.0	16.0	16.0	16.0	17.0	16.0	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	13.	14.	10.	10.	16.	13.	13.	-	9.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	3.00	2.60	3.80	4.00	4.20	1.40	4.00	-	2.20
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	34.	31.	34.	32.	37.	31.	33.	-	24.
Ce	73.	68.	72.	67.	77.	71.	71.	-	54.

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	AKB12 UNKN GRAN	AKB13 UNKN GRAN	AKB19 UNKN GRAN	AKB27 UNKN GRAN	AKB31 UNKN GRAN	AKB32 UNKN GRAN	AKB33 UNKN GRAN	AKB42 UNKN GRAN	AKB43 UNKN GRAN
SiO_2	68.94	70.77	67.65	68.13	71.16	67.68	65.95	75.11	75.58
TiO_2	.59	.46	.70	.56	.42	.64	.67	.13	.23
Al_2O_3	14.11	13.93	14.60	14.46	13.81	14.70	14.90	13.04	12.05
Fe_2O_3	.87	.80	1.00	.76	.70	.68	.88	.16	.54
FeO	3.27	2.56	3.77	3.45	2.38	4.03	4.42	1.10	1.28
MnO	.06	.05	.07	.06	.05	.07	.07	.03	.04
MgO	1.91	1.34	2.13	2.26	1.25	2.22	2.56	.43	.71
CaO	2.46	2.18	2.65	2.45	2.05	2.26	2.87	.96	1.26
Na_2O	2.22	2.46	2.08	1.84	2.45	1.92	1.99	2.80	2.62
K_2O	3.53	3.71	3.06	3.97	3.93	3.60	3.43	5.11	4.07
P_2O_5	.13	.13	.15	.13	.12	.15	.21	.11	.10
H_2O+	1.20	1.00	1.43	1.34	1.05	1.51	1.57	.80	1.05
H_2O-	.31	.27	.30	.20	.21	.22	.21	.10	.15
CO_2	.14	.04	.16	.12	.09	.12	.16	.07	.09
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.74	99.70	99.75	99.73	99.67	99.80	99.89	99.95	99.77
Fe_2O_3t	4.50	3.64	5.18	4.59	3.34	5.15	5.79	1.38	1.96
A/CNK	1.2	1.2	1.3	1.2	1.2	1.3	1.2	1.1	1.1
DI	73.6	78.2	70.1	72.0	79.5	71.1	67.4	90.9	87.9
Ba	460.	470.	510.	720.	445.	475.	385.	190.	280.
Rb	170.	190.	149.	117.	195.	183.	193.	253.	198.
Sr	128.	115.	139.	157.	117.	139.	136.	50.	91.
Y	31.	38.	31.	29.	40.	27.	29.	30.	33.
Zr	194.	176.	207.	170.	178.	187.	161.	68.	107.
Nb	-	-	-	-	-	-	-	-	-
Th	19.20	20.00	20.20	20.00	18.60	19.20	14.40	10.60	14.60
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	64.0	55.0	81.0	71.0	83.0	82.0	93.0	17.0	28.0
Cu	18.5	6.0	20.0	17.5	14.5	16.5	20.5	9.5	5.0
Ni	14.5	10.5	21.0	21.0	10.0	20.0	25.5	1.5	4.0
TiO_2	-	-	-	-	-	-	-	-	-
V	81.	54.	88.	86.	51.	87.	100.	12.	24.
Cr	47.	31.	54.	60.	28.	61.	87.	8.	9.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	13.	10.	16.	17.	7.	17.	18.	3.	6.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	3.80	2.20	3.60	3.00	4.40	4.00	2.40	3.80	2.20
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	32.	30.	37.	37.	29.	33.	31.	12.	18.
Ce	67.	64.	77.	74.	60.	68.	62.	25.	42.

Figure D.1 (cont.). Geochemical database.

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	AKB44 UNKN GRAN	AKB45 UNKN GRAN	AKB46 UNKN GRAN	AKB47 UNKN GRAN	AKB51 UNKN GRAN	AKB52 UNKN GRAN	AKB55 UNKN GRAN	AKB56 UNKN GRAN	AKB57 UNKN GRAN
SiO_2	71.00	73.79	69.41	68.72	69.16	67.58	72.54	67.66	72.70
TiO_2	.43	.24	.62	.57	.48	.68	.24	.56	.34
Al_2O_3	13.83	13.40	14.39	14.36	14.16	14.76	13.45	14.15	13.21
Fe_2O_3	.76	.37	.50	.81	.85	.60	.47	1.03	.79
FeO	2.33	1.62	3.73	3.36	2.88	3.85	2.54	3.46	1.86
MnO	.05	.05	.06	.06	.07	.07	.05	.07	.05
MgO	1.19	.75	1.86	1.95	1.72	2.14	.66	2.11	.91
CaO	1.85	1.26	2.21	1.97	2.68	2.58	2.16	3.41	1.81
Na_2O	2.54	2.61	2.24	1.99	2.16	2.14	2.46	2.16	2.62
K_2O	4.09	4.53	3.62	3.94	3.58	3.61	3.72	3.31	3.84
P_2O_5	.12	.12	.14	.16	.15	.17	.12	.13	.12
H_2O+	1.32	.90	1.05	1.65	1.56	1.30	1.23	1.78	1.23
H_2O-	.16	.15	.06	.23	.22	.13	.12	.15	.20
CO_2	.18	.11	.14	.12	.14	.23	.11	.07	.17
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	-	-	-	-	-	-	-	-
TOTAL	99.85	99.90	100.03	99.89	99.81	99.84	99.87	100.05	99.85
Fe_2O_3t	3.35	2.17	4.64	4.54	4.05	4.87	3.29	4.87	2.85
A/CNK	1.2	1.2	1.2	1.3	1.2	1.2	1.1	1.1	1.1
DI	80.8	86.6	74.2	74.9	74.1	71.2	80.9	69.4	83.0
Ba	475.	250.	475.	475.	495.	485.	525.	435.	470.
Rb	201.	259.	183.	196.	185.	177.	172.	155.	189.
Sr	103.	65.	115.	138.	163.	142.	143.	178.	109.
Y	36.	27.	28.	30.	35.	27.	31.	30.	34.
Zr	171.	90.	187.	182.	152.	190.	153.	159.	163.
Nb	-	-	-	-	-	-	-	-	-
Th	19.00	11.40	16.40	19.00	17.20	18.40	18.40	13.40	19.40
Pb	-	-	-	-	-	-	-	-	-
Ga	-	-	-	-	-	-	-	-	-
Zn	48.0	33.0	67.0	92.0	61.0	74.0	59.0	65.0	45.0
Cu	5.0	2.0	16.5	18.5	9.0	21.0	4.0	9.0	4.0
Ni	9.5	5.0	15.5	18.5	12.5	19.5	2.0	11.0	5.0
TiO_2	-	-	-	-	-	-	-	-	-
V	49.	25.	89.	74.	74.	82.	24.	96.	38.
Cr	26.	14.	49.	54.	43.	50.	5.	41.	18.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	11.	5.	12.	13.	13.	15.	5.	13.	8.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	2.40	3.20	3.40	3.40	1.80	3.00	1.60	2.60	3.20
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	28.	15.	27.	34.	31.	32.	37.	33.	29.
Ce	59.	32.	58.	70.	64.	67.	75.	70.	62.

Figure D.1 (cont.). Geochemical database.

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	AKB61 UNKN GRAN	AKO10 UNKN GRAN	AKO11 UNKN GRAN	AKO12 UNKN GRAN	AKO14 UNKN GRAN	AKO15 UNKN GRAN	AKO17 UNKN GRAN	AKO18 UNKN GRAN	AKO19 UNKN GRAN
SiO_2	68.43	71.86	69.61	68.94	71.46	71.02	71.24	70.77	67.65
TiO_2	.58	.36	.59	.59	.43	.43	.49	.46	.70
Al_2O_3	14.25	13.72	14.08	14.11	13.85	13.74	13.56	13.93	14.60
Fe_2O_3	.74	.71	.93	.87	.51	.84	.78	.80	1.00
FeO	3.53	2.02	3.04	3.27	2.55	2.34	2.34	2.56	3.77
MnO	.07	.05	.06	.06	.05	.05	.05	.05	.07
MgO	2.03	1.08	1.68	1.91	1.30	1.35	1.24	1.34	2.13
CaO	2.30	1.95	2.24	2.46	2.11	2.07	1.72	2.18	2.65
Na_2O	2.03	2.55	2.31	2.22	2.49	2.37	2.31	2.46	2.08
K_2O	3.85	4.11	3.57	3.53	3.85	4.13	4.55	3.71	3.06
P_2O_5	.15	.12	.12	.13	.12	.14	.14	.13	.15
H_2O+	1.43	.85	1.21	1.20	.83	.95	.97	1.00	1.43
H_2O-	.21	.20	.28	.31	.20	.37	.29	.27	.30
CO_2	.12	.08	.05	.14	.08	.13	.12	.04	.16
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	-	.14	.18	.17	.16	.15	.17	.16	.19
TOTAL	99.72	99.80	99.95	99.91	99.99	100.08	99.97	99.86	99.94
Fe_2O_3t	4.66	2.95	4.30	4.50	3.34	3.44	3.38	3.64	5.18
A/CNK	1.2	1.1	1.2	1.2	1.1	1.1	1.1	1.2	1.3
DI	73.3	81.4	75.6	73.6	79.2	79.6	81.5	78.2	70.1
Ba	515.	425.	525.	460.	465.	420.	465.	470.	510.
Rb	184.	199.	164.	170.	184.	198.	233.	190.	149.
Sr	144.	103.	130.	128.	112.	104.	98.	115.	139.
Y	30.	35.	33.	31.	33.	36.	37.	38.	31.
Zr	176.	134.	206.	194.	170.	153.	197.	176.	207.
Nb	-	9.	12.	11.	10.	10.	12.	11.	12.
Th	19.60	16.80	19.80	19.20	16.20	19.40	23.20	20.00	20.20
Pb	-	30.	24.	26.	27.	26.	32.	25.	24.
Ga	-	15.	16.	17.	15.	15.	16.	16.	18.
Zn	73.0	44.0	59.0	64.0	46.0	53.0	55.0	5.5	81.0
Cu	10.5	5.0	10.0	18.5	6.0	8.0	8.0	6.0	20.0
Ni	19.0	7.5	13.5	14.5	9.0	8.5	9.5	10.5	21.0
TiO_2	-	-	-	-	-	-	-	-	-
V	81.	44.	74.	81.	54.	56.	52.	54.	88.
Cr	63.	22.	40.	47.	28.	24.	30.	31.	54.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	10.0	13.0	15.0	11.0	12.0	10.0	11.0	17.0
Ta	-	-	-	-	-	-	-	-	-
Co	14.	9.	13.	13.	9.	9.	10.	10.	16.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	3.80	2.20	3.60	3.80	4.00	4.00	2.40	2.20	3.60
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	35.	24.	36.	32.	27.	30.	32.	30.	37.
Ce	76.	54.	73.	67.	55.	63.	70.	64.	77.

Figure D.1 (cont.). Geochemical database.

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	AKO23 UNKN GRAN	AKO31 UNKN GRAN	AKO36 UNKN GRAN	AKO37 UNKN GRAN	AKO38 UNKN GRAN	AKO39 UNKN GRAN	AKO41 UNKN GRAN	AKO42 UNKN GRAN	AKO43 UNKN GRAN
SiO2	67.64	71.16	71.53	71.01	68.60	68.64	70.20	75.11	75.58
TiO2	.66	.42	.37	.42	.62	.63	.49	.13	.23
Al2O3	14.68	13.81	13.99	13.92	14.42	14.52	13.87	13.04	12.05
Fe2O3	1.08	.70	.46	.56	.93	.55	.89	.16	.54
FeO	3.26	2.38	2.34	2.56	3.35	3.50	2.53	1.10	1.28
MnO	.07	.05	.04	.05	.07	.06	.05	.03	.04
MgO	2.00	1.25	1.05	1.26	2.13	1.87	1.62	.43	.71
CaO	2.56	2.05	1.93	1.98	1.35	2.44	2.26	.96	1.26
Na2O	2.21	2.45	2.56	2.39	1.93	2.29	2.63	2.80	2.62
K2O	3.69	3.93	4.37	4.08	4.08	3.67	3.65	5.11	4.07
P2O5	.16	.12	.11	.12	.16	.14	.11	.11	.10
H2O+	1.35	1.05	.92	1.20	1.81	1.34	1.17	.80	1.05
H2O−	.24	.21	.07	.14	.26	.13	.20	.10	.15
CO2	.17	.09	.11	.23	.11	.08	.20	.07	.09
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.18	.17	.16	.15	.19	.18	.15	.09	.11
TOTAL	99.95	99.84	100.01	100.07	100.01	100.04	100.02	100.04	99.88
Fe2O3t	4.70	3.34	3.06	3.40	4.65	4.44	3.70	1.38	1.96
A/CNK	1.2	1.2	1.1	1.2	1.4	1.2	1.1	1.1	1.1
DI	72.6	79.5	81.4	79.6	76.2	73.6	77.6	90.9	87.9
Ba	470.	445.	510.	450.	560.	475.	380.	190.	280.
Rb	187.	195.	180.	191.	193.	182.	182.	253.	198.
Sr	145.	117.	118.	108.	112.	136.	120.	50.	91.
Y	29.	40.	40.	36.	30.	30.	35.	30.	33.
Zr	185.	178.	133.	157.	200.	183.	171.	68.	107.
Nb	13.	11.	9.	10.	13.	12.	10.	6.	7.
Th	19.20	18.60	17.40	18.80	21.40	20.00	18.00	10.60	14.60
Pb	29.	59.	31.	33.	29.	27.	21.	35.	27.
Ga	17.	16.	15.	15.	18.	17.	16.	12.	13.
Zn	75.0	83.0	40.0	53.0	97.0	66.0	44.0	17.0	28.0
Cu	19.0	14.5	33.0	7.5	18.0	17.5	7.0	9.5	5.0
Ni	19.0	10.0	6.5	8.5	19.5	15.5	11.0	1.5	4.0
TiO2	-	-	-	-	-	-	-	-	-
V	77.	51.	42.	54.	77.	72.	63.	12.	24.
Cr	52.	28.	22.	25.	52.	40.	36.	8.	9.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	15.0	10.0	10.0	11.0	14.0	14.0	12.0	5.0	6.0
Ta	-	-	-	-	-	-	-	-	-
Co	15.	7.	8.	10.	13.	13.	12.	3.	6.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	3.40	4.40	3.60	2.80	4.80	4.60	2.20	3.80	2.20
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	34.	29.	26.	29.	36.	34.	29.	12.	18.
Ce	70.	60.	55.	59.	77.	72.	63.	25.	42.

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	AK044 UNKN GRAN	AK045 UNKN GRAN	AK046 UNKN GRAN	AK052 UNKN GRAN	AK057 UNKN GRAN	AK059 UNKN GRAN	AK09 UNKN GRAN	AM0107 UNKN GRAN	AM0118 UNKN GRAN
SiO_2	71.00	73.79	69.41	67.58	72.70	75.11	69.19	69.52	73.98
TiO_2	.43	.24	.62	.68	.34	.10	.59	.55	.26
Al_2O_3	13.83	13.40	14.39	14.76	13.21	13.17	14.04	14.45	13.51
Fe_2O_3	.76	.37	.50	.60	.79	.34	.71	.45	.33
FeO	2.33	1.62	3.73	3.85	1.86	1.02	3.36	3.01	1.43
MnO	.05	.05	.06	.07	.05	.03	.06	.08	.05
MgO	1.19	.75	1.86	2.14	.91	.34	1.83	1.20	.36
CaO	1.85	1.26	2.21	2.58	1.81	1.31	2.14	2.00	1.45
Na_2O	2.54	2.61	2.24	2.14	2.62	3.48	2.07	3.25	3.05
K_2O	4.09	4.53	3.62	3.61	3.84	3.97	3.69	3.98	4.71
P_2O_5	.12	.12	.14	.17	.12	.05	.14	.15	.15
H_2O+	1.32	.90	1.05	1.30	1.23	.68	1.48	.86	.44
H_2O-	.16	.15	.06	.13	.20	.13	.31	.15	.08
CO_2	.18	.11	.14	.23	.17	.12	.08	.14	.11
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.16	.11	.17	.18	.15	.12	.18	.18	.15
TOTAL	100.01	100.01	100.20	100.02	100.00	99.97	99.87	99.97	100.06
Fe_2O_3t	3.35	2.17	4.64	4.87	2.85	1.47	4.44	3.79	1.92
A/CNK	1.2	1.2	1.2	1.2	1.1	1.1	1.2	1.1	1.1
DI	80.8	86.6	74.2	71.2	83.0	89.6	74.7	79.7	88.3
Ba	475.	250.	475.	485.	470.	465.	520.	600.	580.
Rb	201.	259.	183.	177.	189.	154.	176.	157.	206.
Sr	103.	65.	115.	142.	109.	111.	129.	186.	144.
Y	36.	27.	28.	27.	34.	32.	32.	33.	33.
Zr	171.	90.	187.	190.	163.	71.	184.	181.	122.
Nb	11.	8.	12.	13.	9.	7.	12.	8.	7.
Th	19.00	11.40	16.40	18.40	19.40	14.00	11.80	16.00	14.00
Pb	28.	32.	24.	28.	28.	28.	27.	22.	22.
Ga	16.	14.	17.	17.	15.	14.	17.	-	-
Zn	48.0	33.0	67.0	74.0	45.0	13.0	62.0	67.0	42.0
Cu	5.0	2.0	16.5	21.0	4.0	.5	17.0	14.0	8.0
Ni	9.5	5.0	15.5	19.5	5.0	.5	15.5	9.0	4.0
TiO_2	-	-	-	-	-	-	-	-	-
V	49.	25.	89.	82.	38.	11.	74.	51.	16.
Cr	26.	14.	49.	50.	18.	5.	44.	19.	6.
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	10.0	7.0	18.0	16.0	9.0	7.0	14.0	11.0	5.0
Ta	-	-	-	-	-	-	-	-	-
Co	11.	5.	12.	15.	8.	2.	11.	15.	7.
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	2.40	3.20	3.40	3.00	3.20	2.80	3.80	4.00	4.00
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	-	-
Mo	-	-	-	-	-	-	-	-	-
La	28.	15.	27.	32.	29.	17.	32.	25.	19.
Ce	59.	32.	58.	67.	62.	37.	68.	58.	44.

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	AMO120 UNKN GRAN	AMO122 UNKN GRAN	AMO125 UNKN GRAN	AMU02 UNKN GRAN	AMU07 UNKN GRAN	AMU11 UNKN GRAN	AMU13 UNKN GRAN	ARP2 UNKN GRAN	ARP3 UNKN GRAN
SiO_2	72.37	73.52	74.92	75.93	71.57	70.88	65.86	70.26	70.79
TiO_2	.39	.27	.28	.11	.32	.51	.80	.44	.50
Al_2O_3	14.04	13.79	12.76	12.91	14.53	14.11	15.34	14.93	14.46
Fe_2O_3	.38	.28	.20	.10	.21	.28	.81	.54	.62
FeO	1.83	1.42	1.32	.86	1.88	2.67	4.21	1.98	2.73
MnO	.05	.04	.03	.01	.05	.08	.10	.04	.05
MgO	.57	.35	.34	.28	.53	.94	1.76	.86	1.34
CaO	1.61	1.47	1.22	.59	1.68	1.67	2.94	2.02	1.40
Na_2O	3.11	3.10	3.05	2.82	3.44	3.11	3.39	3.07	2.25
K_2O	4.57	4.57	4.77	5.51	4.49	4.32	3.17	4.26	4.40
P_2O_5	.14	.12	.06	.13	.14	.09	.17	.22	.28
H_2O+	.59	.54	.66	-	-	-	-	.94	1.10
H_2O-	.12	.10	.17	-	-	-	-	.15	.06
CO_2	.20	.09	.21	-	-	-	-	.08	.14
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.17	.15	.13	-	-	-	-	-	-
TOTAL	100.14	99.81	100.12	99.25	98.84	98.66	98.55	99.79	100.12
Fe_2O_3t	2.41	1.86	1.67	1.05	2.30	3.24	5.48	2.74	3.65
A/CNK	1.1	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.3
DI	85.9	87.6	90.1	92.9	84.7	81.6	70.3	82.1	81.0
Ba	630.	510.	420.	-	-	-	-	666.	518.
Rb	173.	206.	203.	-	-	-	-	217.	239.
Sr	151.	185.	96.	-	-	-	-	282.	121.
Y	32.	35.	31.	-	-	-	-	22.	37.
Zr	172.	133.	148.	-	-	-	-	-	-
Nb	6.	8.	5.	-	-	-	-	-	-
Th	16.00	15.00	20.00	-	-	-	-	20.00	20.00
Pb	26.	24.	20.	-	-	-	-	36.	46.
Ga	-	-	-	-	-	-	-	-	-
Zn	58.0	44.0	29.0	-	-	-	-	-	-
Cu	13.0	8.0	7.0	-	-	-	-	-	-
Ni	5.0	3.0	2.0	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	28.	16.	15.	-	-	-	-	-	-
Cr	9.	5.	3.	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	5.0	5.0
Cs	-	-	-	-	-	-	-	9.0	23.0
Sc	7.0	5.0	5.0	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	10.	4.	5.	-	-	-	-	-	-
Li	-	-	-	-	-	-	-	-	-
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
U	3.00	6.00	3.00	-	-	-	-	7.00	4.00
W	-	-	-	-	-	-	-	-	-
Sn	-	-	-	-	-	-	-	5.0	11.0
Mo	-	-	-	-	-	-	-	-	-
La	24.	21.	23.	-	-	-	-	-	-
Ce	56.	45.	54.	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	ARP4 UNKN GRAN	ARP5 UNKN GRAN	ARP6 UNKN GRAN	ASB717 UNKN GRAN	ASB718 UNKN GRAN	ASB721 UNKN GRAN	ASB726 UNKN GRAN	ASB754 UNKN GRAN	ASB765 UNKN GRAN
SiO_2	71.42	70.88	72.20	72.30	72.73	73.41	75.84	75.12	72.08
TiO_2	.47	.44	.26	.34	.45	.30	.16	.09	.36
Al_2O_3	14.09	14.74	13.87	14.66	14.01	14.09	13.25	13.75	14.30
Fe_2O_3	.62	.63	1.22	–	–	–	–	–	–
FeO	2.66	2.55	1.23	2.42	2.73	2.03	1.50	1.05	2.74
MnO	.06	.04	.08	–	–	–	–	–	–
MgO	1.54	1.32	.26	1.02	1.31	1.09	.63	.59	1.04
CaO	.81	.64	1.35	1.67	1.54	1.71	.89	1.29	2.15
Na_2O	1.95	1.93	3.77	2.86	2.46	3.29	2.95	2.95	3.09
K_2O	3.73	4.55	4.27	4.50	4.49	3.86	4.58	4.95	3.94
P_2O_5	.19	.21	.06	.22	.27	.21	.20	.20	.28
H_2O+	1.21	1.13	.94	–	–	–	–	–	–
H_2O-	.14	.14	.25	–	–	–	–	–	–
CO_2	.11	.11	.08	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.00	99.31	99.84	99.99	99.99	99.99	100.00	99.99	99.98
Fe_2O_3t	3.57	3.46	2.59	2.69	3.03	2.25	1.67	1.17	3.04
A/CNK	1.6	1.6	1.0	1.2	1.2	1.1	1.2	1.1	1.1
DI	80.3	82.3	88.6	83.0	82.1	84.0	89.8	89.3	81.1
Ba	435.	410.	164.	–	–	–	–	–	–
Rb	186.	283.	370.	–	–	–	–	–	–
Sr	104.	88.	73.	–	–	–	–	–	–
Y	45.	21.	59.	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	14.00	14.00	48.00	–	–	–	–	–	–
Pb	46.	39.	40.	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	5.0	4.0	6.0	–	–	–	–	–	–
Cs	37.0	25.0	47.0	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	5.00	5.00	12.00	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	13.0	11.0	16.0	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	ASB793 UNKN GRAN	ASB799 UNKN GRAN	ASB830 UNKN GRAN	ASB831 UNKN GRAN	ASB837 UNKN GRAN	ASB844 UNKN GRAN	ASB846 UNKN GRAN	ASB857 UNKN GRAN	ASB861 UNKN GRAN
SiO_2	73.37	74.20	70.91	74.63	71.93	72.12	74.18	71.39	71.88
TiO_2	.23	.42	.52	.22	.52	.42	.34	.35	.31
Al_2O_3	14.26	13.15	14.37	13.64	13.54	14.44	13.33	15.18	14.26
Fe_2O_3	–	–	–	–	–	–	–	–	–
FeO	1.52	2.93	3.31	1.83	3.28	2.92	2.19	2.33	1.86
MnO	–	–	.01	–	–	–	–	–	.04
MgO	.84	1.21	1.59	.83	1.41	1.14	.82	1.05	.67
CaO	1.72	1.68	2.26	1.38	1.86	1.73	1.39	1.78	1.90
Na_2O	3.89	2.49	2.92	2.82	2.49	2.51	2.88	2.69	4.26
K_2O	4.01	3.74	3.85	4.50	4.74	4.50	4.66	5.06	4.75
P_2O_5	.15	.18	.27	.15	.22	.21	.19	.17	.07
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	–
TOTAL	99.99	100.00	100.01	100.00	99.99	99.99	99.98	100.00	100.00
Fe_2O_3t	1.69	3.25	3.67	2.03	3.64	3.24	2.43	2.59	2.06
A/CNK	1.0	1.2	1.1	1.1	1.1	1.2	1.1	1.2	.9
DI	86.4	81.5	77.8	86.3	80.6	81.2	86.3	82.5	87.5
Ba	–	–	–	–	–	–	–	–	–
Rb	–	–	–	–	–	–	–	–	–
Sr	–	–	–	–	–	–	–	–	–
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	ASB864 UNKN GRAN	ASB866 UNKN GRAN	ASB869 UNKN GRAN	ASB879 UNKN GRAN	ASB881 UNKN GRAN	ASB883 UNKN GRAN	ASB887 UNKN GRAN	ASB889 UNKN GRAN	AST1 UNKN GRAN
SiO_2	73.80	72.03	74.98	71.93	75.64	72.94	71.98	70.23	69.78
TiO_2	.20	.53	.17	.28	.15	.34	.29	.57	.57
Al_2O_3	14.13	14.31	13.90	15.24	13.15	14.25	14.31	14.65	14.56
Fe_2O_3	–	–	–	–	–	–	–	–	–
FeO	1.98	3.39	1.45	2.21	1.22	2.08	1.76	3.68	3.66
MnO	.04	–	.06	.01	–	–	.04	.01	.01
MgO	.27	1.33	.36	.85	.51	.81	.75	1.40	1.40
CaO	.91	1.91	.76	1.84	1.15	1.52	1.80	1.86	1.85
Na_2O	3.01	2.32	3.21	3.19	2.90	2.54	4.28	2.62	2.60
K_2O	5.45	4.01	4.98	4.28	5.17	5.36	4.67	4.77	4.74
P_2O_5	.21	.17	.12	.17	.11	.16	.11	.19	.19
H_2O+	–	–	–	–	–	–	–	–	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	.71
TOTAL	100.00	100.00	99.99	100.00	100.00	100.00	99.99	99.98	100.07
Fe_2O_3t	2.20	3.76	1.61	2.45	1.35	2.31	1.95	4.08	4.06
A/CNK	1.1	1.2	1.2	1.2	1.1	1.1	.9	1.1	1.1
DI	89.8	78.5	90.9	82.9	90.3	85.3	87.5	78.9	78.4
Ba	–	–	–	–	–	–	–	–	–
Rb	–	–	–	–	–	–	–	–	–
Sr	–	–	–	–	–	–	–	–	–
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	AST2 UNKN GRAN	AST3 UNKN GRAN	AST4 UNKN GRAN	AWB1 UNKN GRAN	AWB14 UNKN GRAN	AWB15 UNKN GRAN	AWB16 UNKN GRAN	AWB17 UNKN GRAN	AWB2 UNKN GRAN
SiO_2	72.21	74.63	71.83	75.32	76.54	74.68	74.93	74.79	75.21
TiO_2	.34	.09	.36	.10	.19	.31	.06	.40	.10
Al_2O_3	14.64	13.66	14.25	12.97	12.05	12.80	13.45	12.67	13.10
Fe_2O_3	–	–	–	.44	.47	.60	.44	.79	.40
FeO	2.42	1.05	2.73	.95	1.10	1.45	.87	1.60	.90
MnO	–	–	–	.03	.03	.03	.03	.03	.03
MgO	1.02	.59	1.04	.19	.38	.59	.18	.69	.20
CaO	1.67	1.29	2.14	1.56	.66	1.04	1.30	1.35	1.55
Na_2O	2.86	2.94	3.08	2.97	2.39	2.37	2.88	2.36	3.02
K_2O	4.50	4.91	3.93	4.30	4.90	4.79	4.63	4.59	4.33
P_2O_5	.22	.22	.28	.03	.13	.13	.04	.12	.03
H_2O+	–	–	–	.71	.80	1.03	.79	.87	.72
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	.47	.61	.50	–	–	–	–	–	–
TOTAL	100.35	99.99	100.14	99.57	99.64	99.82	99.60	100.26	99.59
Fe_2O_3t	2.69	1.17	3.03	1.49	1.69	2.21	1.41	2.57	1.40
A/CNK	1.2	1.1	1.1	1.1	1.2	1.2	1.1	1.1	1.1
DI	82.9	88.8	80.8	88.6	91.6	88.3	89.4	87.0	88.8
Ba	–	–	–	–	–	–	–	–	–
Rb	–	–	–	–	–	–	–	–	–
Sr	–	–	–	–	–	–	–	–	–
Y	–	–	–	–	–	–	–	–	–
Zr	–	–	–	–	–	–	–	–	–
Nb	–	–	–	–	–	–	–	–	–
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	–
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	–
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	AWB21 UNKN GRAN	AWB22 UNKN GRAN	AWB25 UNKN GRAN	AWB27 UNKN GRAN	AWB29 UNKN GRAN	AWB4 UNKN GRAN	AWB6 UNKN GRAN	AWB9 UNKN GRAN	TBT13 UNKN GRAN
SiO_2	74.40	72.53	72.33	72.79	74.47	76.10	73.28	76.20	71.93
TiO_2	.13	.42	.49	.41	.22	.06	.41	.15	.49
Al_2O_3	13.59	13.72	12.93	13.03	12.82	12.90	13.52	12.47	14.03
Fe_2O_3	.46	.81	.70	1.06	.56	.68	.87	.71	3.50
FeO	1.48	1.93	2.15	1.56	1.71	.46	2.18	.82	–
MnO	.02	.04	.04	.03	.03	.02	.04	.05	.06
MgO	.38	.86	.89	.98	.40	.17	1.01	.32	.84
CaO	1.38	1.85	1.48	1.31	1.63	1.26	2.27	1.20	2.01
Na_2O	2.89	2.41	2.33	2.15	2.60	3.14	3.25	2.81	2.95
K_2O	4.32	4.43	4.32	4.69	3.90	4.43	2.10	4.65	4.15
P_2O_5	.10	.12	.13	.11	.10	.02	.07	.03	.16
H_2O+	.99	.91	.91	1.42	.92	.57	.98	.48	–
H_2O-	–	–	–	–	–	–	–	–	–
CO_2	–	–	–	–	–	–	–	–	–
Cl	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	–
LOI	–	–	–	–	–	–	–	–	.83
TOTAL	100.14	100.03	98.70	99.54	99.36	99.81	99.98	99.89	100.95
Fe_2O_3t	2.10	2.95	3.09	2.79	2.46	1.19	3.29	1.62	3.50
A/CNK	1.1	1.1	1.2	1.2	1.1	1.1	1.2	1.1	1.1
DI	87.7	83.0	82.9	84.9	85.4	91.2	79.6	90.4	83.3
Ba	–	–	–	–	–	–	–	–	538.
Rb	–	–	–	–	–	–	–	–	229.
Sr	–	–	–	–	–	–	–	–	132.
Y	–	–	–	–	–	–	–	–	36.
Zr	–	–	–	–	–	–	–	–	196.
Nb	–	–	–	–	–	–	–	–	12.
Th	–	–	–	–	–	–	–	–	–
Pb	–	–	–	–	–	–	–	–	–
Ga	–	–	–	–	–	–	–	–	20.
Zn	–	–	–	–	–	–	–	–	–
Cu	–	–	–	–	–	–	–	–	–
Ni	–	–	–	–	–	–	–	–	–
TiO_2	–	–	–	–	–	–	–	–	–
V	–	–	–	–	–	–	–	–	–
Cr	–	–	–	–	–	–	–	–	–
Hf	–	–	–	–	–	–	–	–	–
Cs	–	–	–	–	–	–	–	–	–
Sc	–	–	–	–	–	–	–	–	–
Ta	–	–	–	–	–	–	–	–	–
Co	–	–	–	–	–	–	–	–	–
Li	–	–	–	–	–	–	–	–	–
Be	–	–	–	–	–	–	–	–	–
B	–	–	–	–	–	–	–	–	–
F	–	–	–	–	–	–	–	–	770.
Cl	–	–	–	–	–	–	–	–	–
U	–	–	–	–	–	–	–	–	–
W	–	–	–	–	–	–	–	–	–
Sn	–	–	–	–	–	–	–	–	29.0
Mo	–	–	–	–	–	–	–	–	–
La	–	–	–	–	–	–	–	–	–
Ce	–	–	–	–	–	–	–	–	–

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	TBT20 UNKN GRAN	TBT24 UNKN GRAN	TBT26 UNKN GRAN	TBT31 UNKN GRAN	TBT36 UNKN GRAN	TBT39 UNKN GRAN	TBT42 UNKN GRAN	TBT45 UNKN GRAN	TBT47 UNKN GRAN
SiO_2	74.45	72.24	74.00	74.48	74.88	75.75	77.30	75.89	75.55
TiO_2	.30	.26	.16	.50	.28	.08	.06	.13	.10
Al_2O_3	12.70	14.45	13.90	12.93	13.10	13.45	13.10	13.44	12.64
Fe_2O_3	2.27	2.01	1.85	3.20	2.21	1.47	1.68	.39	1.66
FeO	-	-	-	-	-	-	-	-	-
MnO	.04	.04	.02	.04	.02	.02	.04	.01	.04
MgO	.34	.54	.38	.69	.18	.13	.05	.08	.07
CaO	1.47	1.64	1.10	1.51	.97	.85	.49	.55	.61
Na_2O	3.19	2.82	2.90	2.34	2.06	3.45	2.90	2.91	2.83
K_2O	4.15	4.65	4.80	4.03	4.83	4.75	5.10	4.52	4.68
P_2O_5	.10	.19	.11	.13	.13	-	.06	.07	.04
H_2O+	-	-	-	-	-	-	-	-	-
H_2O-	-	-	-	-	-	-	-	-	-
CO_2	-	-	-	-	-	-	-	-	-
Cl	-	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-	-
LOI	.62	.57	1.85	.68	.77	.51	1.00	1.19	.76
TOTAL	99.63	99.41	101.07	100.53	99.43	100.46	101.78	99.18	98.98
Fe_2O_3t	2.27	2.01	1.85	3.20	2.21	1.47	1.68	.39	1.66
A/CNK	1.0	1.1	1.2	1.2	1.3	1.1	1.2	1.3	1.2
DI	88.2	85.6	89.1	85.2	88.4	92.8	94.6	91.9	91.5
Ba	-	369.	298.	683.	387.	267.	27.	141.	148.
Rb	230.	385.	383.	223.	294.	232.	515.	543.	393.
Sr	102.	103.	93.	103.	62.	62.	9.	31.	31.
Y	33.	22.	23.	33.	36.	44.	58.	43.	54.
Zr	131.	119.	109.	257.	178.	73.	68.	106.	110.
Nb	14.	18.	11.	12.	13.	10.	14.	15.	13.
Th	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-
Ga	15.	19.	17.	16.	20.	18.	25.	23.	22.
Zn	-	-	-	-	-	-	-	-	-
Cu	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	-
TiO_2	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
Cr	-	-	-	-	-	-	-	-	-
Hf	-	-	-	-	-	-	-	-	-
Cs	-	-	-	-	-	-	-	-	-
Sc	-	-	-	-	-	-	-	-	-
Ta	-	-	-	-	-	-	-	-	-
Co	-	-	-	-	-	-	-	-	-
Li	55.0	112.0	200.0	41.0	64.0	100.0	122.0	98.0	92.0
Be	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-
F	580.	-	1500.	1200.	1500.	340.	2880.	2820.	2200.
Cl	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	-	-
Sn	9.0	11.0	15.0	5.0	7.0	6.0	32.0	87.0	16.0
Mo	-	-	-	-	-	-	-	-	-
La	-	-	-	-	-	-	-	-	-
Ce	-	-	-	-	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

AUSTRALIA

	TBT49 UNKN GRAN	TBT51 UNKN GRAN	TBT60 UNKN GRAN	TBT61 UNKN GRAN	TBT8 UNKN GRAN
SiO_2	75.50	73.50	76.51	76.07	71.86
TiO_2	-	.03	.01	.02	.33
Al_2O_3	14.00	15.10	13.28	13.30	14.08
Fe_2O_3	1.50	.94	.49	1.12	2.42
FeO	-	-	-	-	-
MnO	.05	.06	-	.02	.05
MgO	.03	.04	.06	.07	.57
CaO	.36	.47	.37	.42	1.74
Na_2O	3.60	3.30	4.04	4.31	3.52
K_2O	4.30	4.30	4.53	4.39	4.46
P_2O_5	.09	.11	.01	-	.12
H_2O+	-	-	-	-	-
H_2O-	-	-	-	-	-
CO_2	-	-	-	-	-
Cl	-	-	-	-	-
F	-	-	-	-	-
LOI	1.11	.81	.69	.60	1.24
TOTAL	100.54	98.66	99.99	100.32	100.39
Fe_2O_3t	1.50	.94	.49	1.12	2.42
A/CNK	1.3	1.4	1.1	1.1	1.0
DI	93.4	90.4	95.8	95.6	86.2
Ba	20.	22.	35.	31.	371.
Rb	820.	1562.	353.	366.	270.
Sr	6.	11.	7.	7.	121.
Y	31.	19.	60.	65.	36.
Zr	34.	25.	63.	68.	123.
Nb	20.	60.	16.	17.	11.
Th	-	-	-	-	-
Pb	-	-	-	-	-
Ga	32.	41.	21.	23.	16.
Zn	-	-	-	-	-
Cu	-	-	-	-	-
Ni	-	-	-	-	-
TiO_2	-	-	-	-	-
V	-	-	-	-	-
Cr	-	-	-	-	-
Hf	-	-	-	-	-
Cs	-	-	-	-	-
Sc	-	-	-	-	-
Ta	-	-	-	-	-
Co	-	-	-	-	-
Li	260.0	465.0	25.0	63.0	77.0
Be	-	-	-	-	-
B	-	-	-	-	-
F	4240.	4020.	-	740.	820.
Cl	-	-	-	-	-
U	-	-	-	-	-
W	-	-	-	-	-
Sn	30.0	35.0	10.0	11.0	12.0
Mo	-	-	-	-	-
La	-	-	-	-	-
Ce	-	-	-	-	-

Figure D.1 (cont.). Geochemical database.

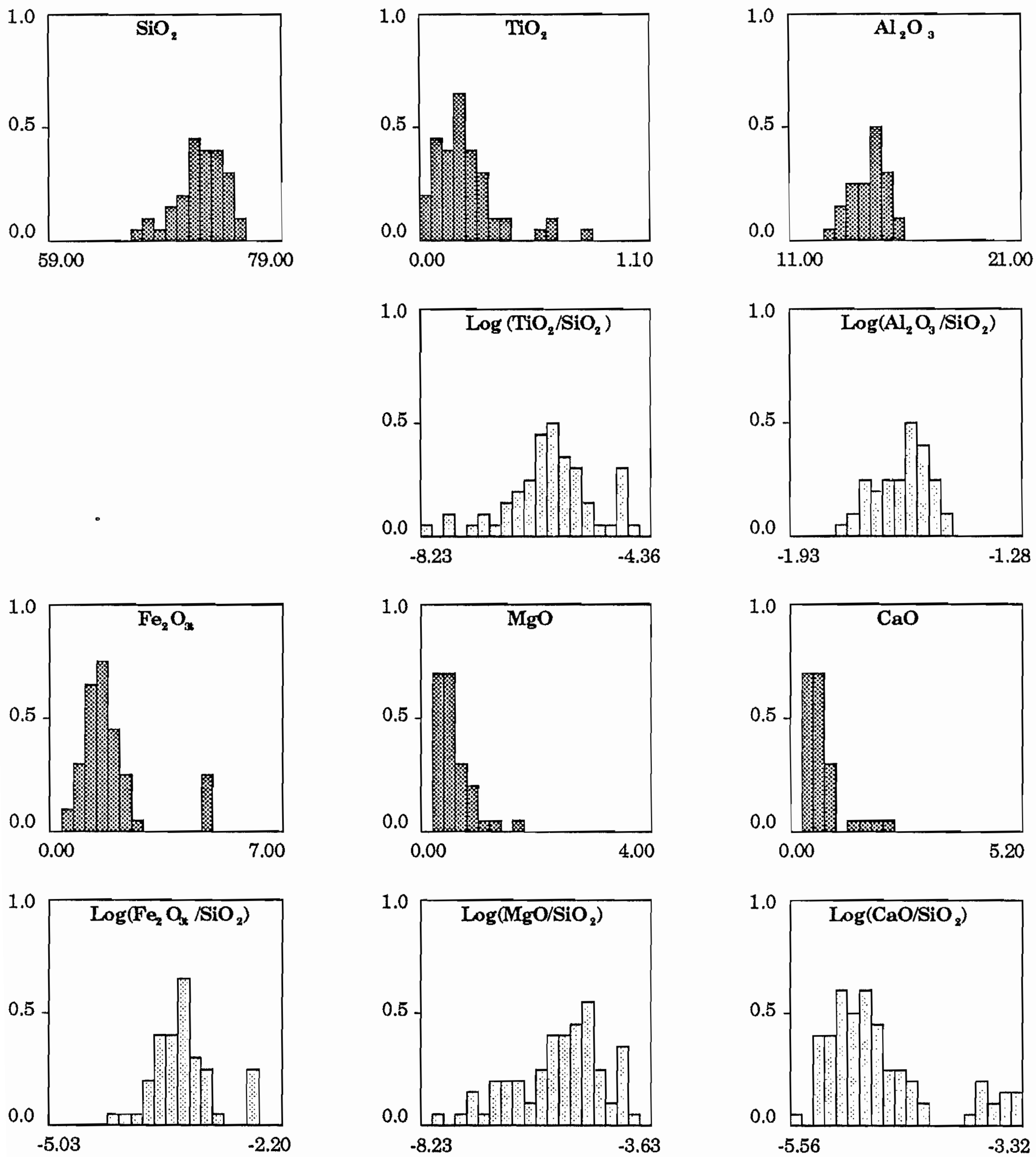

Figure E.1. Frequency distributions of major and trace element data from Northern Nova Scotia.

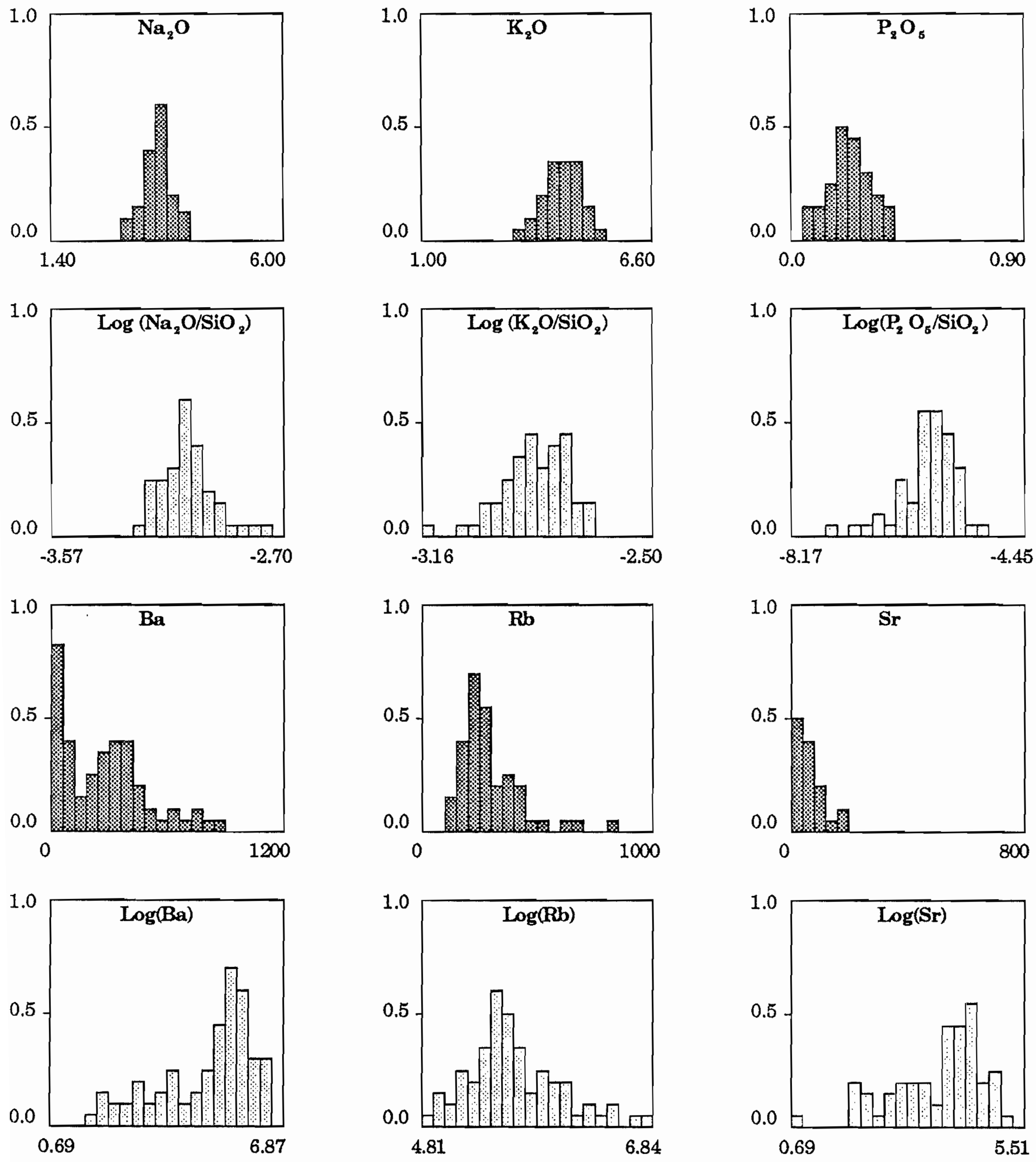

Figure E.1 (cont.). Frequency distributions of major and trace element data from Northern Nova Scotia.

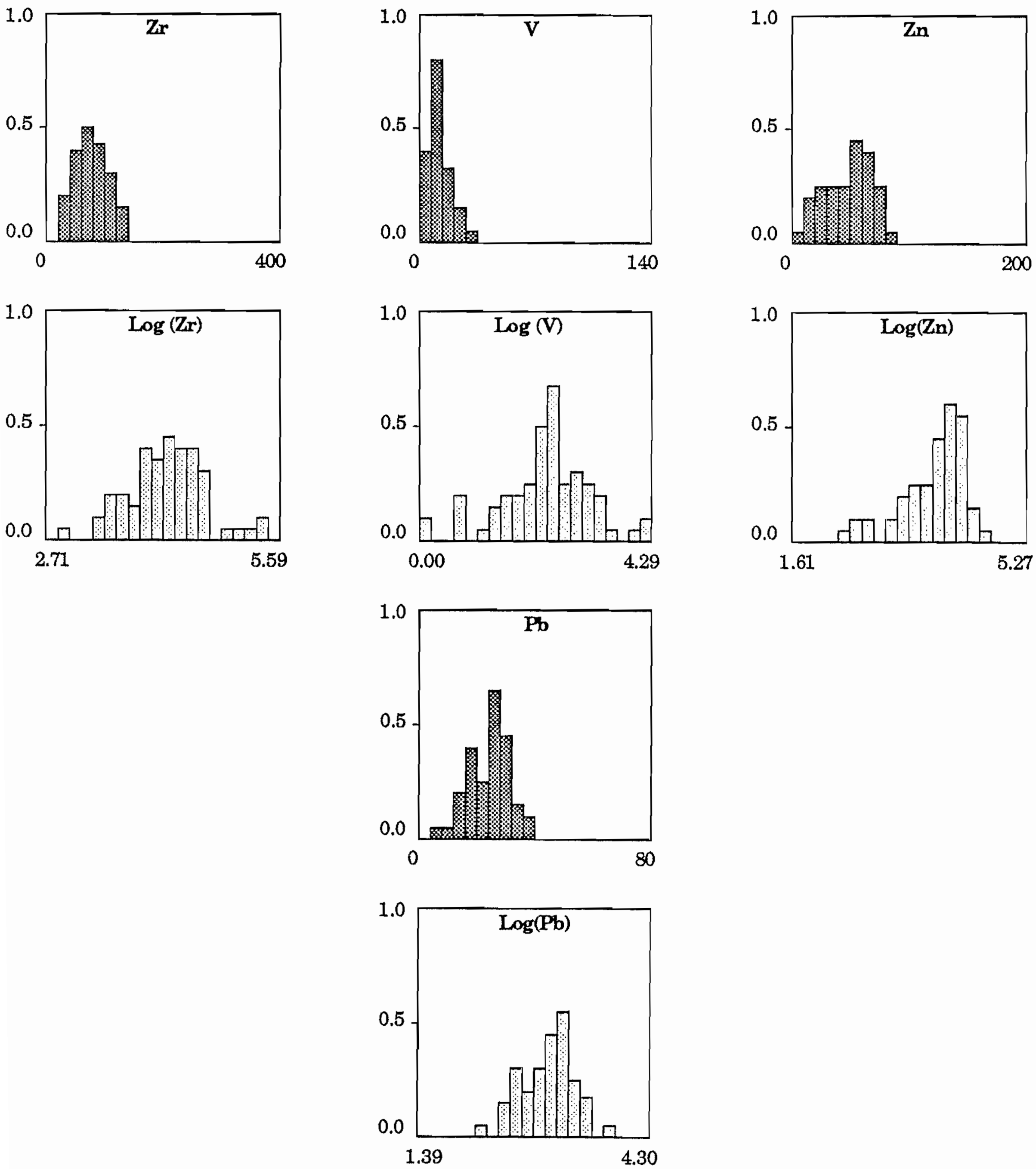

Figure E.1 (cont.). Frequency distributions of major and trace element data from Northern Nova Scotia.

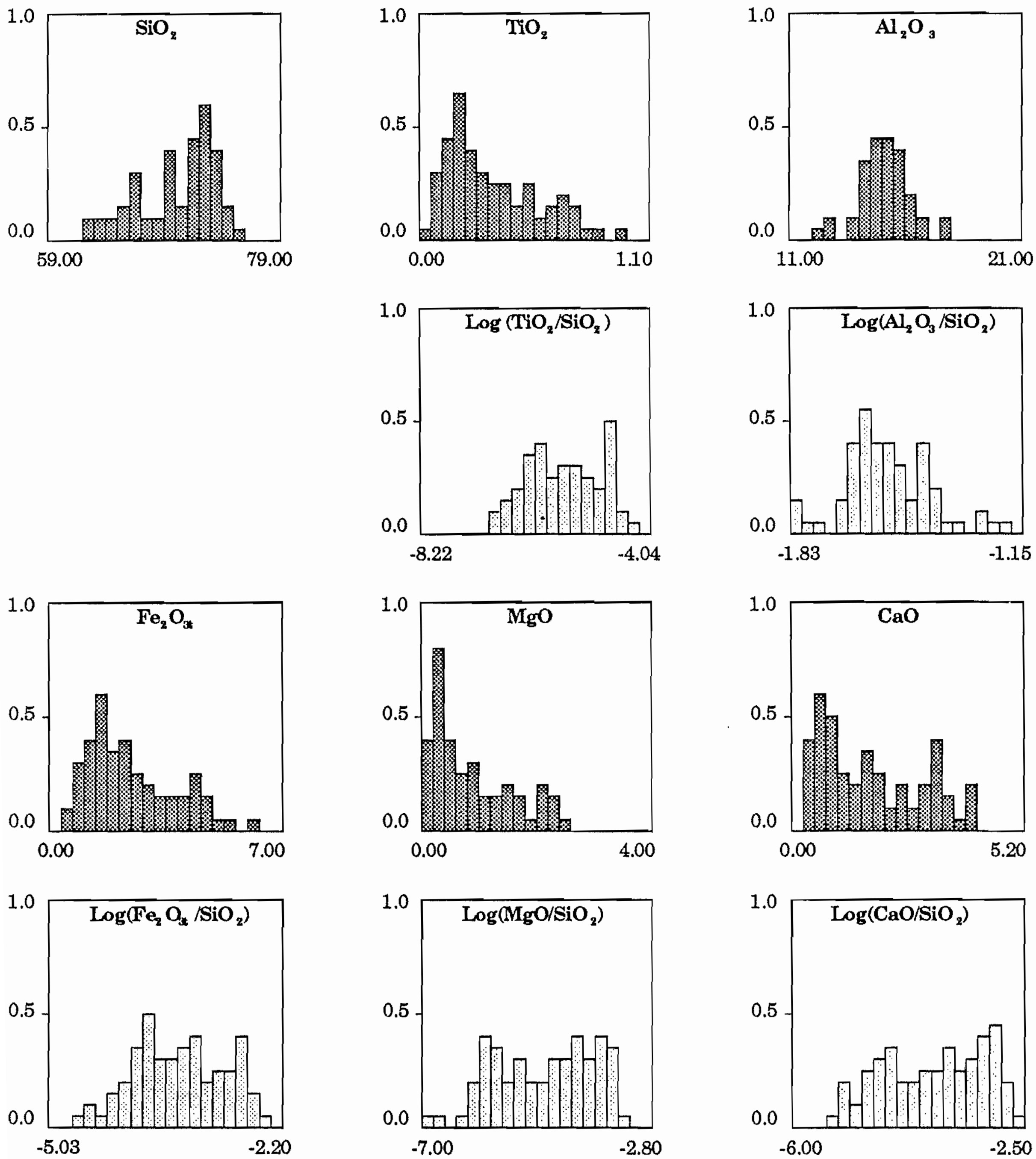

Figure E.2. Frequency distributions of major and trace element data from Southern Nova Scotia.

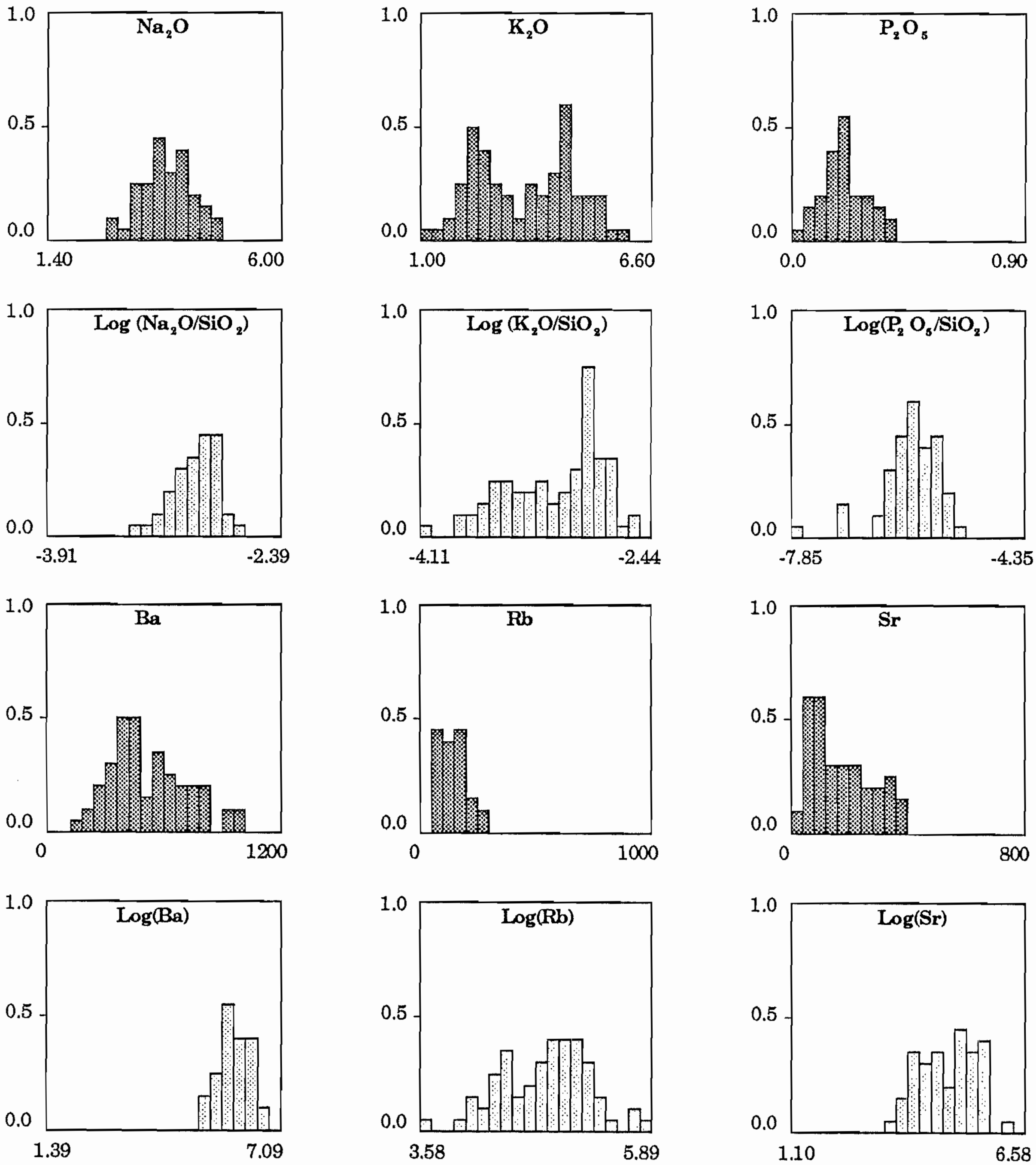

Figure E.2 (cont.). Frequency distributions of major and trace element data from Southern Nova Scotia.

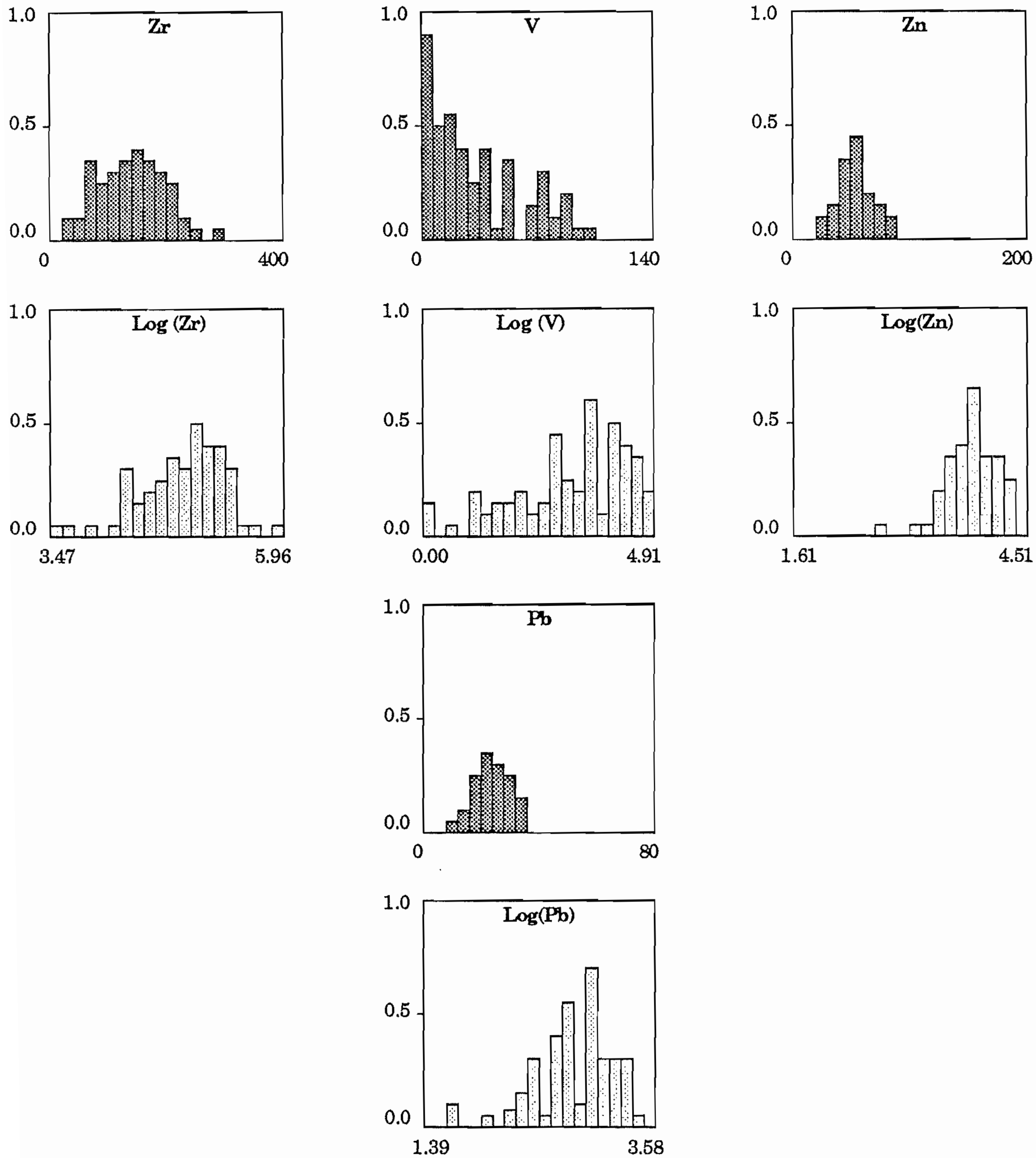

Figure E.2 (cont.). Frequency distributions of major and trace element data from Southern Nova Scotia.

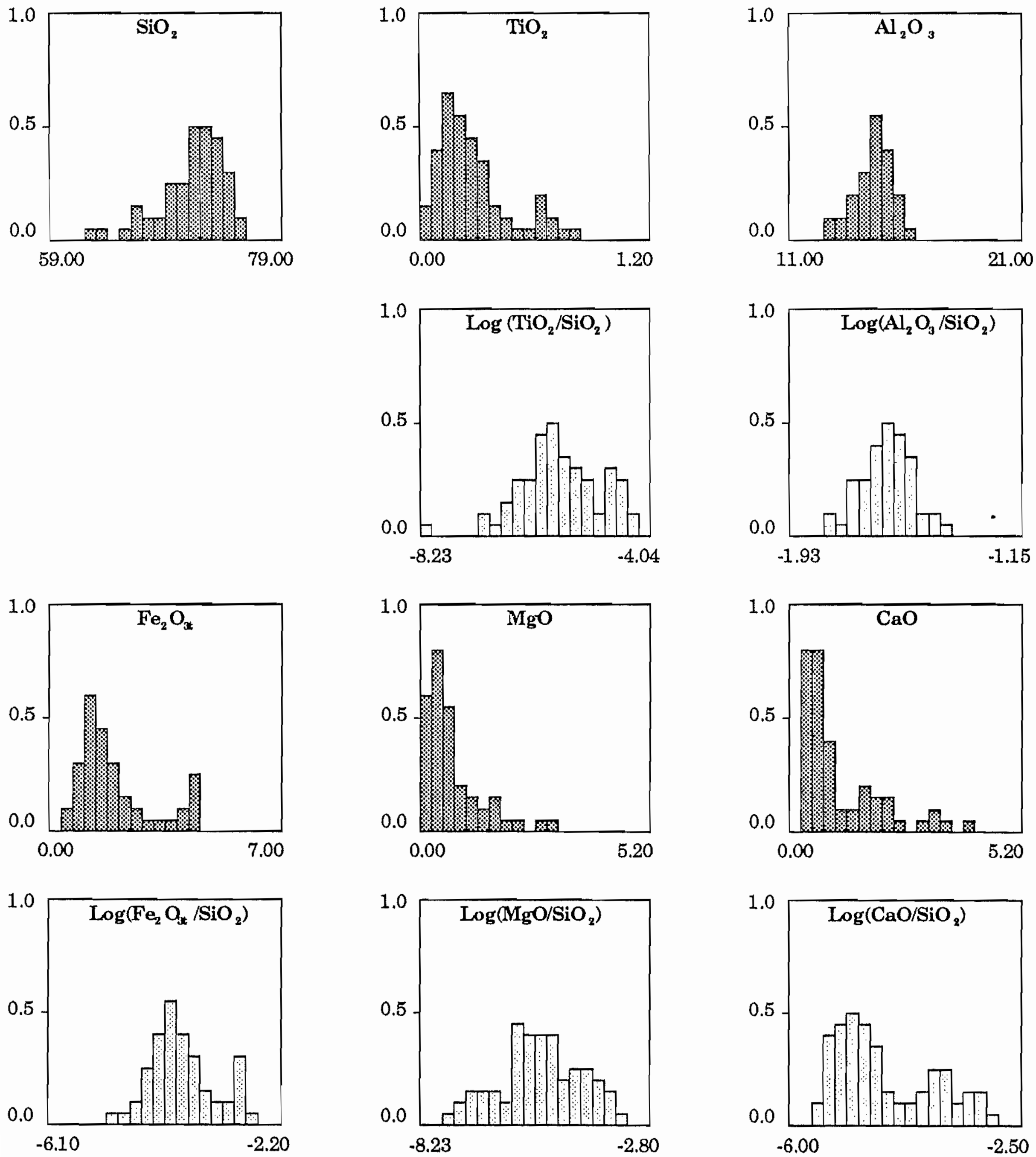

Figure E.3. Frequency distributions of major and trace element data from Nova Scotia.

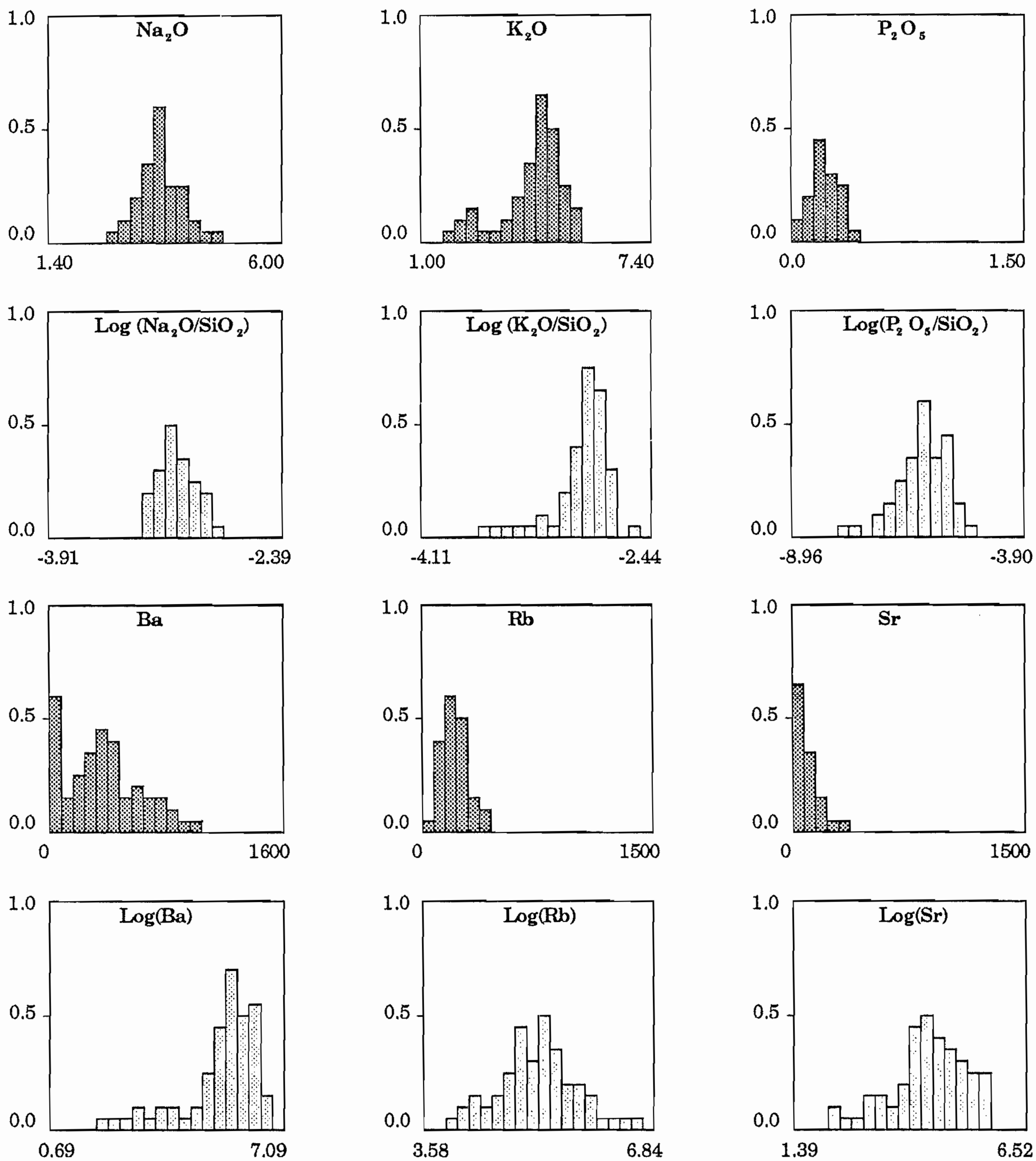

Figure E.3 (cont.). Frequency distributions of major and trace element data from Nova Scotia.

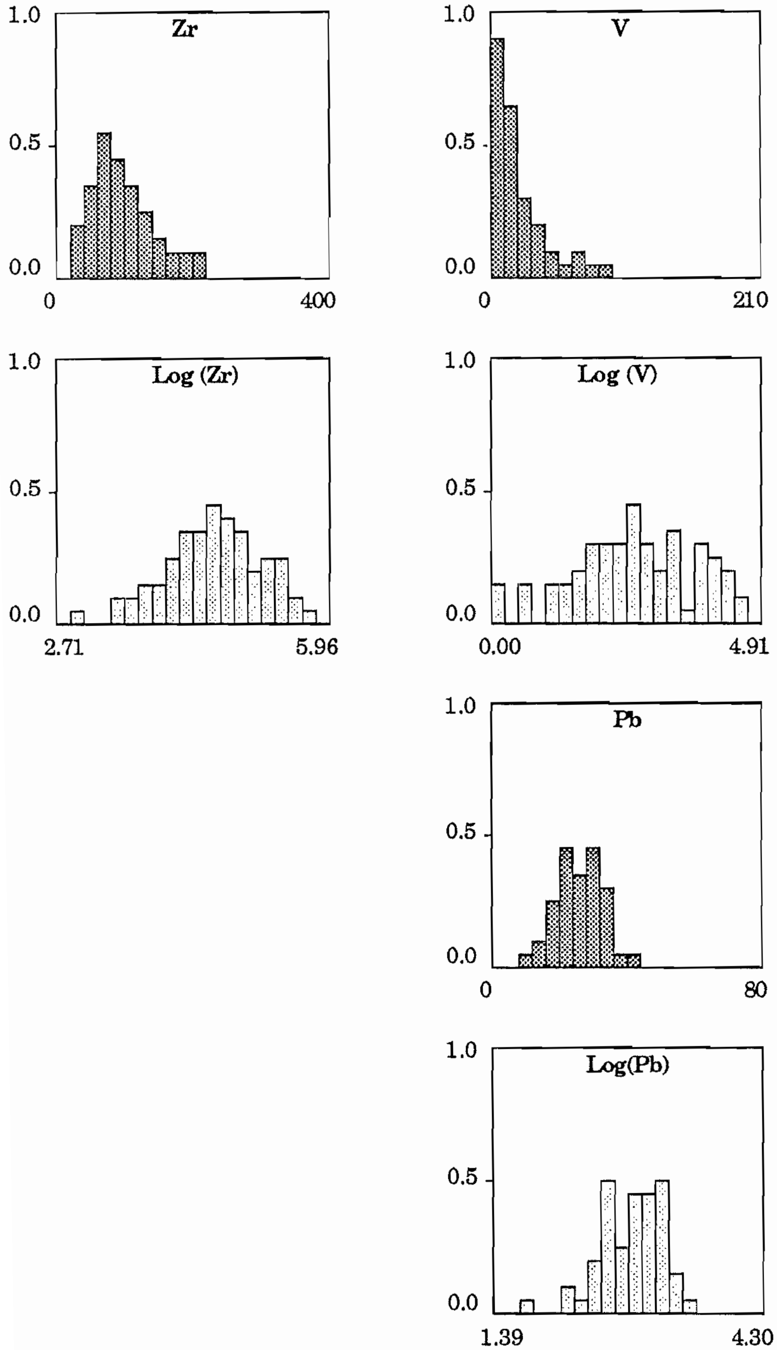

Figure E.3 (cont.). Frequency distributions of major and trace element data from Nova Scotia.

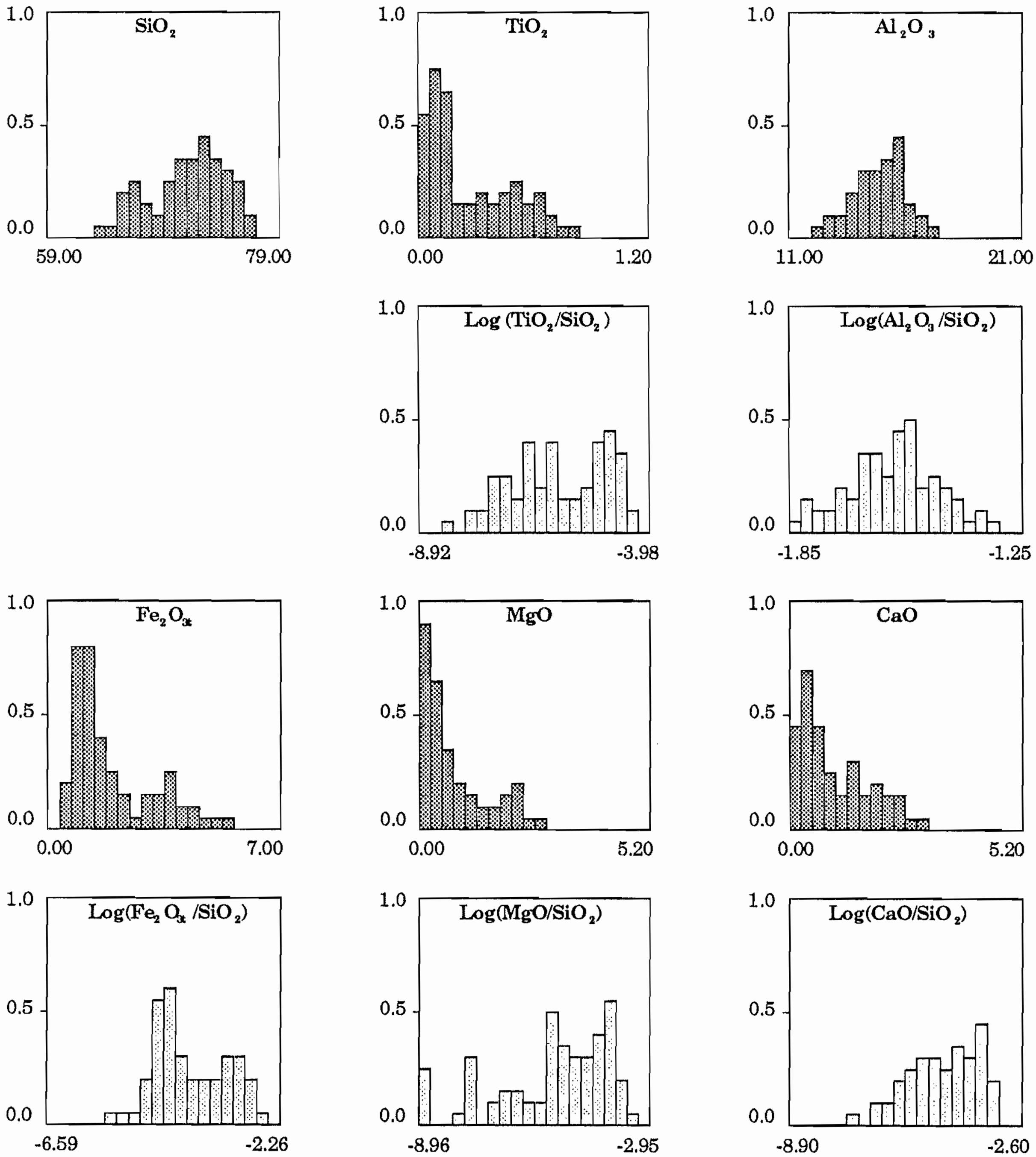

Figure E.4. Frequency distributions of major and trace element data from Morocco.

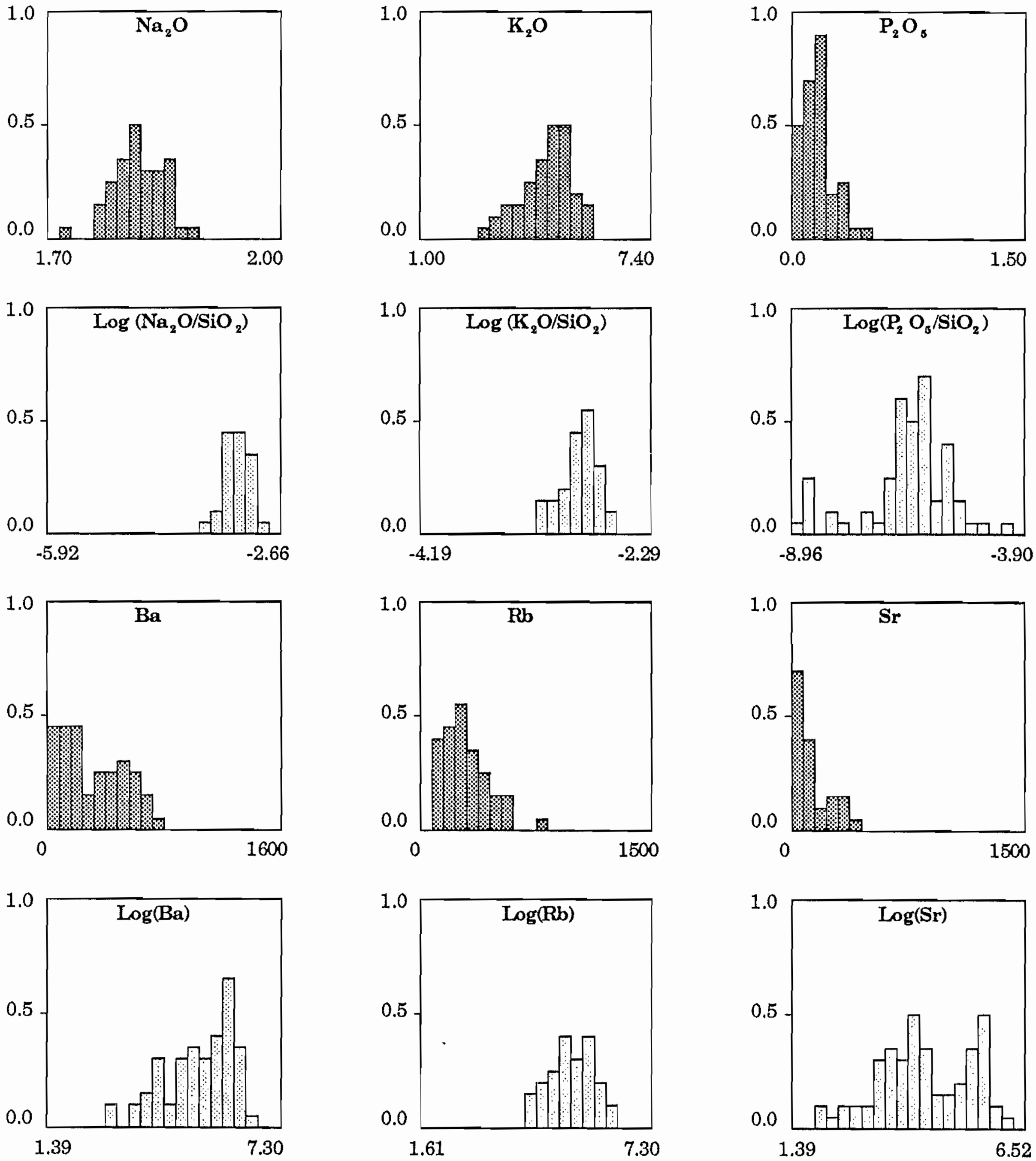

Figure E.4 (cont.). Frequency distributions of major and trace element data from Morocco.

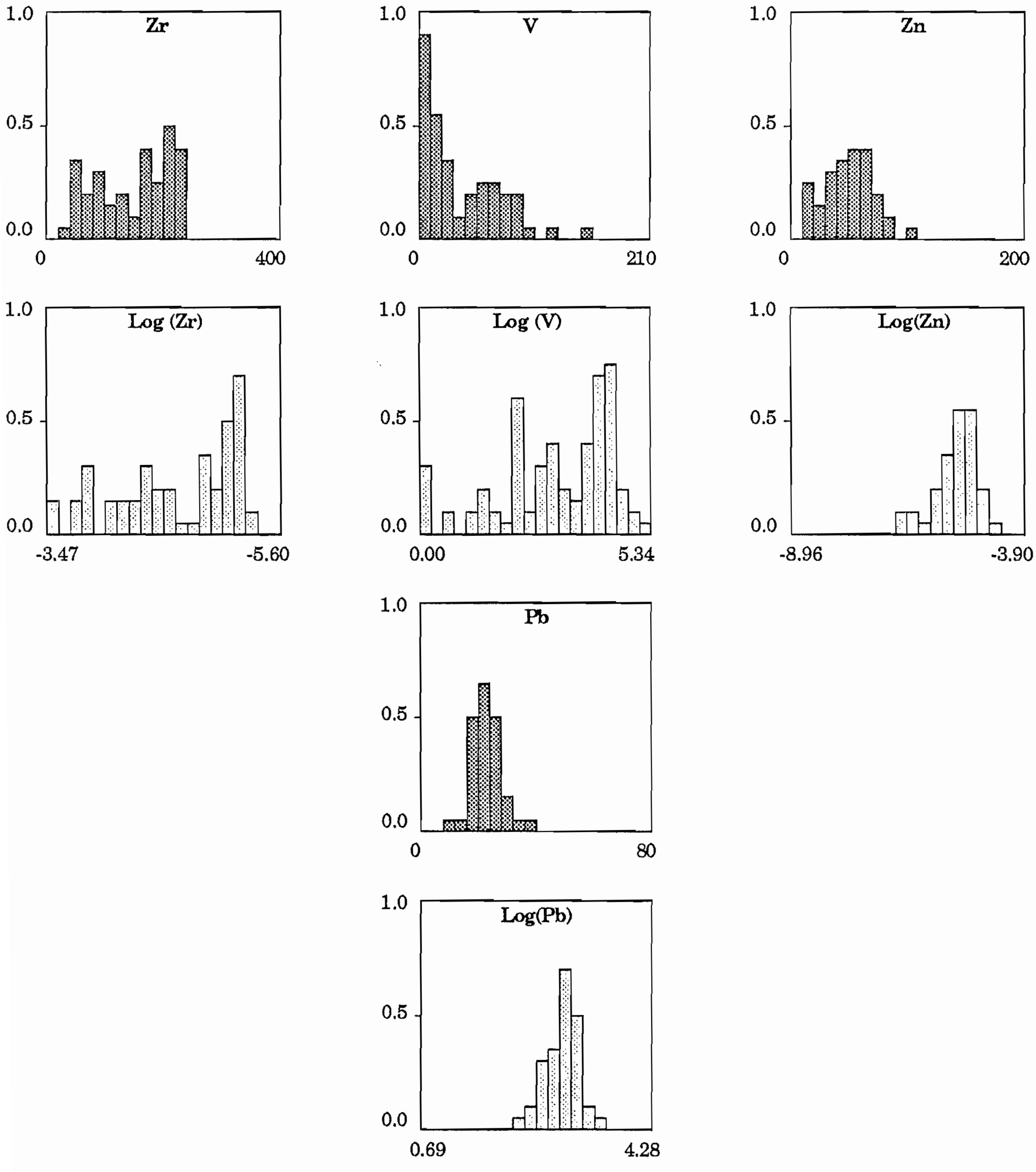

Figure E.4 (cont.). Frequency distributions of major and trace element data from Morocco.

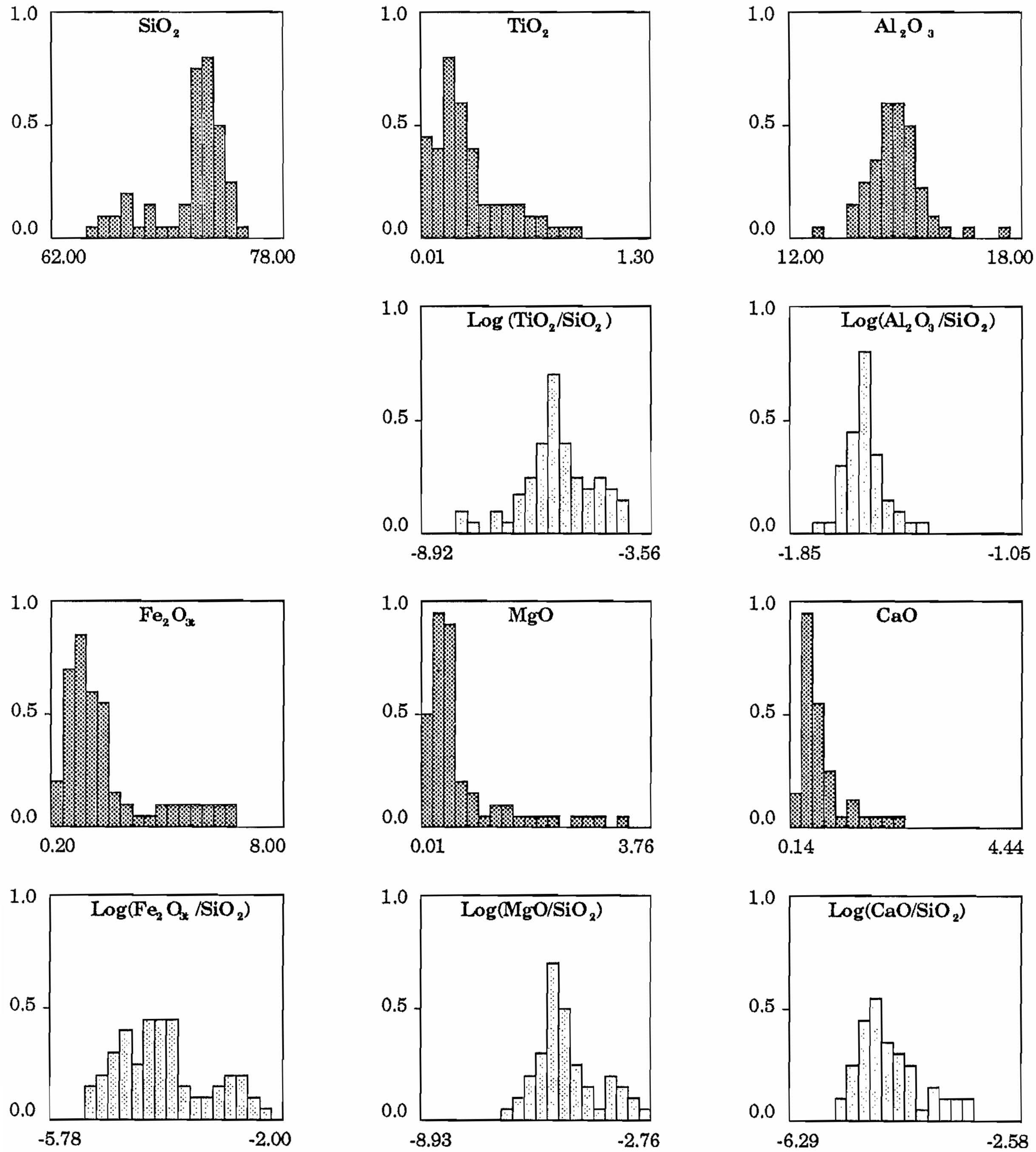

Figure E.5. Frequency distributions of major and trace element data from Iberia.

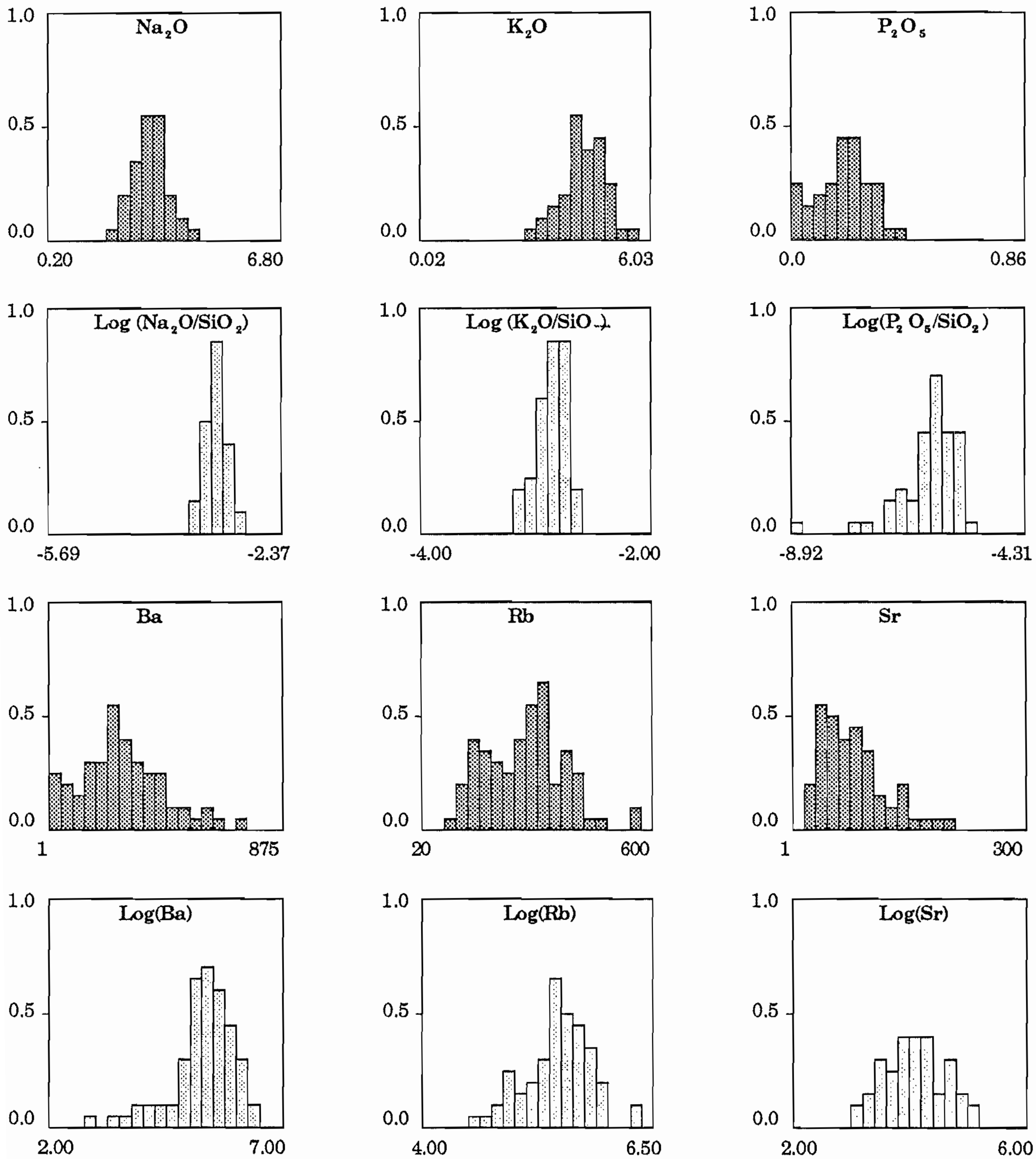

Figure E.5 (cont.). Frequency distributions of major and trace element data from Iberia.

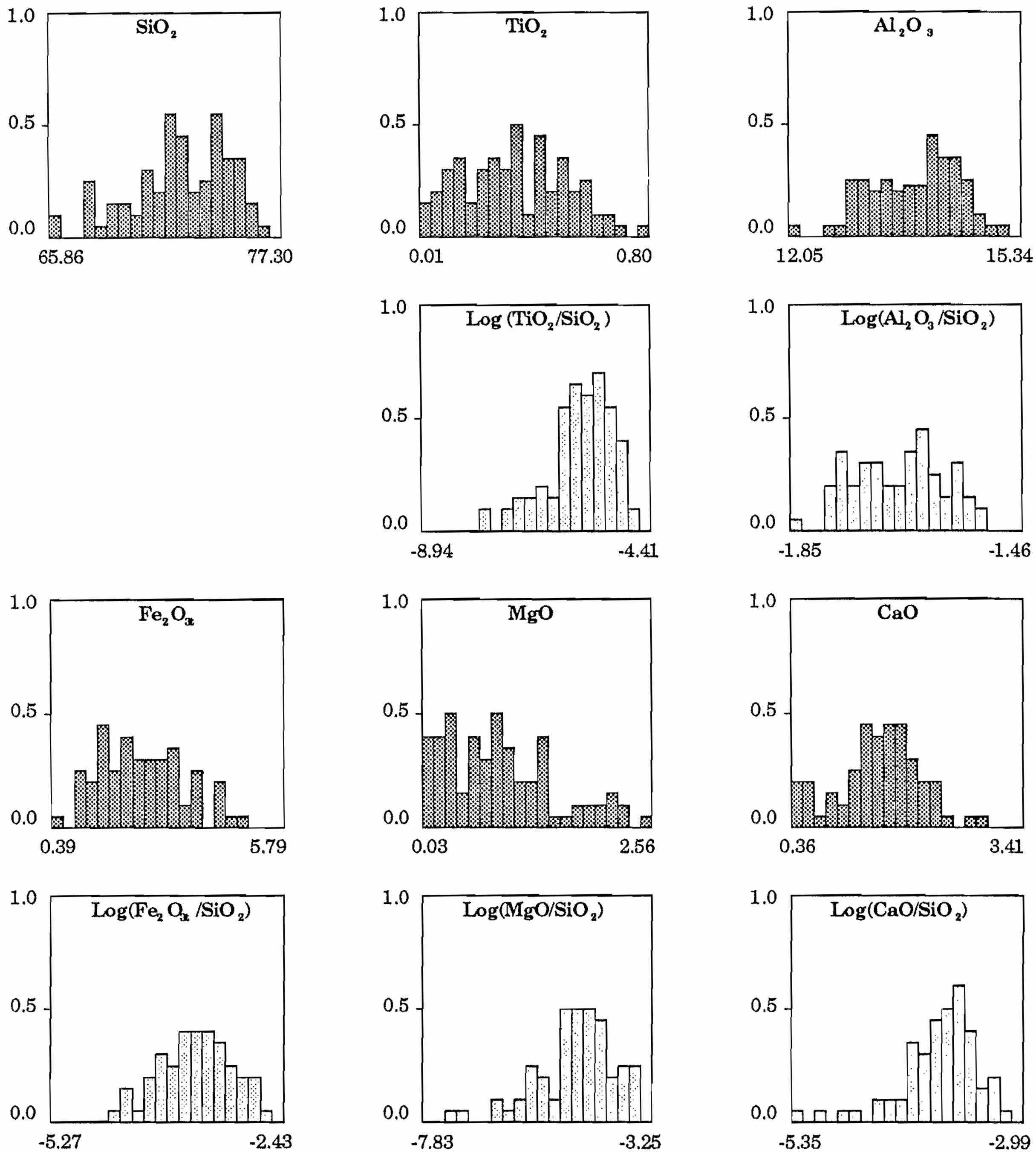

Figure E.6. Frequency distributions of major and trace element data from Australia.

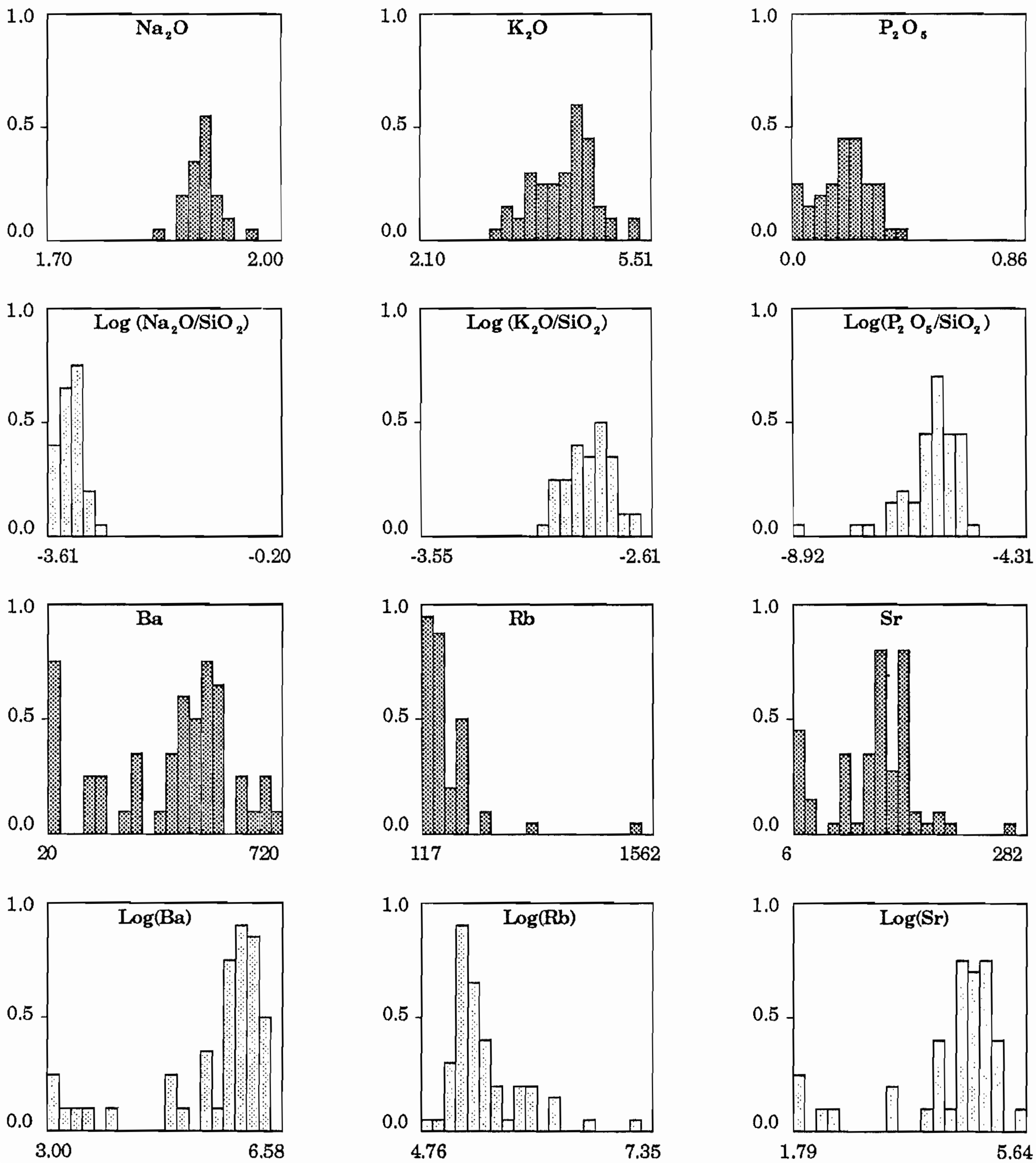

Figure E.6 (cont.). Frequency distributions of major and trace element data from Australia.

APPENDIX F

ADDITIONAL INFORMATION ON DISCRIMINANT FUNCTION ANALYSIS

F.1 Determining the number of discriminant functions

Generally the number of discriminant functions calculated in an analysis is determined by the number of groups (g) and independent (i.e. discriminating) variables (p). The maximum number of possible discriminant functions calculated in an analysis will be the smaller of g-1 and p. For example in a four-group and ten-variable discriminant analysis, a maximum of 3 functions could be computed.

The importance of the number of groups stems from the basic geometric principle that the maximum number of dimensions needed to describe a set of points is one less than the number of points. The degenerate situation of three points falling within a line, for example, is an exception to this rule. The last point falls into the space defined by the two first points and does not add a new dimension. The same principles apply to discriminant analysis. Each group (as defined by its centroid) is treated as a point and each discriminant function is a unique dimension describing the location of that group relative to the others. In some cases not all discriminant functions are significant or useful. For example, if in a four-group analysis only two discriminant functions are computed this case is degenerate and the third function is omitted because of its statistical insignificance. That is, although the two first discriminant functions do not contain all of the information in the discriminating variables, the small amount left in the third possible function is ignored because it is judged to be statistically insignificant.

F.2 Judging the Importance of a Discriminant Function

The eigenvalue is the measure of the relative importance of a particular discriminant function. The sum of all eigenvalues represents the total variance in the discriminating variables. Therefore, the relative importance of an eigenvalue (consequently the discriminant function) can be calculated as a percentage of the total sum of eigenvalues.

F.3 Discriminant Function Coefficients and Discriminant Scores

A discriminant score is calculated using the discriminant function in which the raw value for each variable is multiplied by its corresponding coefficient and these products are then added together. There is a separate score for each case and each discriminant function. The group mean of a function is calculated by averaging the scores for all cases within a particular group. The group centroid is the mean of all functions in a given group.

F.4 Plots of Discriminant Scores

In a two-group model in which one discriminant function is calculated, a histogram is used to depict the discriminant scores. When two discriminant functions are calculated, the discriminant scores are plotted in binary form with each function representing an axis. In addition a territorial map is also produced. Each point on this graph is classified according to its relationship with the nearest group centroid (see Nie et al., 1975 Section 23.2.5 for details on classification rules). Only the borders of regions for each group are shown on the final printout. This is done by plotting only the points not completely surrounded by points classified in the same group. The result is a graph which could identify group membership of a case.

F.5 Minimum Tolerance Test

Discriminant analysis determines the tolerance level of each variable in an analysis to avoid difficulties in subsequent calculations (Nie et al., 1975). Essentially a low tolerance level indicates that the program would encounter some difficulty during matrix inversions, and if such a variable where to be included in the analysis, large rounding errors would result and lead to faulty classifications of the data. Thus, if a variable fails the minimum tolerance test, discriminant function analysis will not include this variable in the analysis.

F.6 Wilks' Lambda Criterion

The differences between several group means can generally be tested using the Wilks' Lambda criterion. However, in cases where the data are closed, the Wilks' Lambda is indeterminate and can not be calculated using the standard method. An alternative method exists which can calculate the Wilks' Lambda value by matrix inversion. It is, however, unclear in SPSS how the discriminant procedure would treat this statistic in such a situation. Because of this uncertainty, the Wilks' Lambda values were not considered in this thesis.

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