better told by some one more competent to the task, but I have not met with anything upon the subject of the sac and tubes except in Camper's works. The notes of Dr. Sommers, which he kindly handed to me to be used as I saw fit, are given in full, as those which might have been made by me would only be the notes of a hunter, and therefore of but little value in comparison. I regret that I have been unable to explain more fully the use of the sac, but what additional light has been added may possibly encourage some other, naturalist or hunter, to continue the enquiry.

Art. VI.—Nova Scotian Meteorology. By F. Allison, Esq., M. A., *Chief Meteorological Agent.*

(*Read before the Institute, 14th May*, 1877.)

The facts, deductions, and opinions, brought before this Institute in this little paper, are the results of over fourteen years of personal observation at Halifax, of all elements entering into the constitution of climate; to which are added several previous years of observation of Temperature and Rain by the Medical Officers at the Citadel, which were taken under excellent supervision, and considered to be trustworthy enough for scientific calculation. I have also been much assisted by many careful observers through this Province, and in Prince Edward Island, and Newfoundland, to whom I would thus publicly tender my thanks; and some of whom are now performing good service in the Dominion Meteorological organization. Most of the following remarks, though taken directly at and for Halifax, are applicable to all Nova Scotia. The deviations from this general rule will be noted as we proceed.

Heat—its degree and alternations—must of course lie at the bottom of all considerations of climate; but for several reasons of convenience, the first instrument we record is the Barometer.

Let me again mention, that beside almost all Barometers having a considerable error in themselves, they are commonly observed by the public without regard to the marking of the attached Ther-

mometers, or their height above the level of the sea. Obviously, their readings are constantly wrong, generally too low. It may be argued, that if the readings be always made from the same instrument, merely to test the condition of the atmosphere at the one point, and not for comparative or scientific purposes, they serve the end sought. But this is not correct, even with this small object alone in view, for the temperature will always affect the mercurial column; and as it cannot be kept regular to a degree, these simple readings must prove erroneous. Thus, let the observed height of the column be 29.750, and the attached Thermometer 70°, and again, let the same observed height remain, but with temperature reduced to 40°—which may easily happen in any room—and the ordinary observer says that the pressure is the same; whereas, if the first instance be only 29.750 in reality, the latter observation is .080 higher, or 29.830, else the Barometer could not retain its apparent height with 30° reduction of temperature. Therefore, when I speak of Barometrical Height, or Pressure of Atmosphere, I mean with all corrections included, viz., instrumental error corrected, temperature calculated at 32°, Fahrenheit freezing point, and addition made for height above sea. Aneroid Barometers are not used in Meteorology, as though very useful in measuring elevation, they are very apt to get out of order without the observer's knowledge, and their rate of error is uncertain, beside the metal scale being unduly affected by heat, and they cannot be set to a point to obviate the expansion and contraction. The mean Pressure for the whole year at Halifax is 29.779, and this is near enough to that of other parts of the Province for application to any climatological purpose. The Barometer here has risen to 30.992, and fallen to 28.455, but from 29.000 to 30.500 inches is the general range, and readings outside of these limits are very rare. Our Barometrical altitude is comparatively low for our Latitude, but the weight of atmosphere is affected, like the other Meteorological constituents, by our Peninsular position, and proximity to the great ocean. Thus the mean Barometer in 1875, at Halifax, in Latitude 44°.39′ N., was 0.151 inches lower than that at the inland station of Brockville in Ontario, in almost the very same Latitude—44°.34,

while at Esquimault, in British Columbia, as we again approach the ocean on the West, the Barometer comes down again nearer the Nova Scotia means, although that station is 2 degrees farther North than any point in Nova Scotia where the observations are recorded. This comparatively small Pressure helps our climate to produce agricultural results, belonging to a more southern latitude inland, shewing that the atmosphere is lighter, because warmer. The equability of this Pressure is also our safeguard against the violent storms, which to the South, the West, the North, and East of us, rage frequently, but seldom touch this Province, its extreme limits being the most exposed to their ravages. This again, is partly due to the level surface of Nova Scotia; and when we complain of the monotony of our low sea coast, and the want of abrupt hills through the country, we should remember the compensation gained by our comparative immunity from high winds and heavy rains. The warmer (and lighter) air over the Gulf Stream to the Southward, and the mild waters of the Bay of Fundy to the North and West, assist in keeping level our Barometers, and thus preserving the general regularity of our climate.

Before leaving this topic of whole pressure, I will allude briefly to a much neglected item in calculating the weight of the atmosphere. The pressure, or elastic force of vapour, must be eliminated from the total, before we can get what we really want,—the dry air to be weighed by itself. This vapour, with relative humidity, is calculated from tables carefully prepared from the reading of the wet bulb Thermometer, and the difference between it and the day or true temperature of air. There is but a very slight discrepancy between Glaisher's tables for this purpose and Guyot's, but the latter is preferred, and is computed from the third edition of Regnault's tensions, in which he has "modified the numerical values of some of the coefficients" of the formula adopted. The barometric height is supposed to be 29.700 inches. "Enter the tables with the difference of the two thermometers, and the temperature of the wet-bulb given by observation. In the column headed by the observed difference of the thermometers, and on the horizontal line headed by the observed temperature of the wet

thermometer, are found the force of vapour and the relative humidity corresponding to these temperatures." Let the apparent height of the column, reduced to 32° and to sea-level, be 29.800 inches, the temperature of air 43°, and of the wet-bulb 40°,—the difference thus being 3°; then you will use the psychrometrical table as above, and subtract 0.208 as force of vapour, giving the result—

29.800 inches.
— 0.208 "
29.592 "

as pressure of dry air, and the relative humidity will be 75.0. But suppose the barometer, and the difference between dry and wet bulbs, to be still the same, but the wet to be fallen to 33°, then you will subtract only 0.149, giving—

29.800 inches.
— 0.149 "
29.651 "

as dry pressure, and a relative humidity of 70.5. This will readily explain how necessary it is to take into account the temperature and difference of the bulbs, when calculating climatological results from barometric observations. The difference is increased or diminished simply by evaporation, depending again upon the capability of the atmosphere to hold moisture. Even in the heaviest rains there is generally a degree or more of difference between the thermometers; but a fog is complete saturation, or 100 per cent. of relative humidity.

As Nova Scotia has a less pressure than corresponds to its latitude, so should it have a greater heat than its proper due; but the immense stretches of snow and ice prevent that during the longer portion of the year; and as these frozen regions of land and water lie from the north-west to the north-east of us, and exert their influence over us from November to June, we have less heat during that period than might otherwise be expected. The mean yearly temperature of Halifax is 42°.81; of Digby, 43°.50; of

Truro, 41°; of Sydney, 41°.50; and of Baddeck, 39°.90. The series are not quite long enough to strike so accurate a normal at these country stations as in this city; but I have selected some of the best, at widely distant localities, and the errors will, I think, prove in time to be not very important. At St. John, N.B., in 1875, (the latest finished year that I have) the mean temperature was 38°.3, against 40°.2 at Halifax; 38°.2 and 38°.3 at Charlottetown and Georgetown, P. E. I., respectively; and 39°.1, 38°.1 and 37°.5 at the stations of Harbor Grace, St. John's, and Channel, in Newfoundland, in order. It is interesting to watch how the mean temperatures of each month vary at some of the Nova Scotia stations. In January, Digby is the warmest and Truro coldest. In February again, Digby is highest, but Sydney falls as low as Truro. In March, Digby still remains highest and Sydney lowest. In April, Digby is passed by Wolfville, while Sydney is far behind. In May, Windsor is warmest and Baddeck coldest. In June, the inland station of Windsor is still hottest, and the sea-side Baddeck much the coldest; and in July the extremes are observed at the same stations. But in August, Halifax increases much in proportion, while Baddeck is still the lowest, remaining so in September, when Wolfville marks the highest. In October, the interior becomes much colder, and Halifax is the warmest, and Truro slightly colder than any. Sydney takes first place in November, with Truro still coldest, where the latter remains through December, in which month Digby is a little higher than any. Digby gives the highest mean and Baddeck the lowest of five Nova Scotia stations for the year; but Wolfville, in May, June and August, and Windsor, in the five months following July, are too defective for fair comparisons, otherwise, as warm inland stations, they might contest first place with Digby.

The winds, their direction and force, are very important in deciding climate and calculating its effects. First—As to direction, westwardly winds are much more prevalent in Nova Scotia than those from any other quarter, giving a resultant,—whether we estimate force in connection with direction, or merely count the years' average of daily means,—of a very few degrees N. of W. During

January, February, March and April, the average wind keeps well N. of W. In May, we get it nearly W. In June, still farther S., and again nearly W. S. W., in July. In August and September, we have prevalent W. S. W. winds, going up to near the Winter average in October and November, till in December the N. W. wind prevails. In the Eastern part of Nova Scotia, the wind is more frequently from the East than in these central and Western counties, and there is a comparatively greater tendency to draw from S. E., so that the average wind which is N. of W., taking the Province as a whole, is a little S. of W. in Cape Breton. Rather than a cause, this direction is an effect due to geographical position, and a less humid atmosphere than Europe in the same latitude; so we will pass on to wind force.

The faulty construction, bad exposure, and deficient readings, make many of the Anemometers at out-stations untrustworthy for series sufficiently long to calculate means with accuracy; but from what I have been able to learn so far, the velocities for the Province, when all can be satisfactorily reduced, will not differ to any very great extent from those observed at this Chief Station.

In Halifax the result of 14 years observation places the average velocity about 9 miles per hour, (strictly 9.36), varying from a dead calm up to 63 miles per hour. This latter wonderful velocity I noted in the great gale of Sunday morning, the 3rd of August, 1867, which blew down many fences and trees on the Peninsula, also unroofing several buildings and destroying chimnies, etc. Fortunately the wind which had been S.E. for two days previous, and returned to that point that same evening, had veered S. during the greatest height of the gale, so that the wharves and shipping were partially protected and the destruction there was not so great as in some lesser S.E. gales. But a fearful sea broke on Meagher's Beach. The nearest approach to this wind was on August 24th and 25th, 1873. This will be remembered as the disastrous Cape Breton storm. In Halifax and westward it did not reach the violence exhibited in the Eastern Counties, but it blew up to 60 miles midnight of 24th, and continued very heavy the morning of

the 25th. Here the direction was N. and N.NE. with thunder, lightning, and over 2.5 inches of rain in 22 hours.

Taking up the wind average forces of the months we find January a trifle above the year's normal. February still a little higher. March getting up to the maximum of 11.35. April falls off very much, and May remains much the same as its predecessor. But June shews a mean still less. July and August are far the most quiet months, the former giving an average of only 4.86, the latter the minimum of 4.69. September returns to near the mean of June. October increases a little more, while November approaches very near to March. In these two months the general force of wind is much the greatest. December has an average about equal to January.

Our Peninsular position, equal Barometric distribution, and level surface of country, divert many violent gales from this Province, and we cannot be too thankful that, as one of the most quiet spots of North America, we thus enjoy the most favourable facilities for the production of the land crops peculiar to the Latitude, and safety on our sea coast, compared with other shores of the Atlantic. Even in a station so far inland as Toronto the mean velocity is very much the same as our own. 30 miles an hour is the minimum of a gale, and in 1876 there were 20 gales; in 1875, 19; in 1874, 18; in 1873, 17; in 1872, 26, and in 1871, 26; of these 126 gales, 103 took place between October and March, inclusive. It is very rare to reach 30 miles per hour in May, June, July, or August, though the two heaviest gales, as recorded above, occurred in this latter month. In total precipitation both the rain and the water obtained from snow when melted, are included. The dry snow is first measured on a platform, and has been found to give on an average one-tenth of its depth in water. Thus one inch of level dry snow gives .100 of water over the same superficial area. Occasional the equivalent of 1 inch of snow varies from .090 to .110 of water, but one-tenth is quite near enough for an average. In Great Britain 1 inch of snow rarely measures over .090 of water, as the flakes generally lie much more loosely, and occupy more space than here.

In looking at total precipitation by the month, although the same months in different years vary very much, a tolerably long series—say of 11 years—gives a fair idea of the most wet and dry periods of the year; and in the fourteen complete years from which I now can calculate, the Precipitation of Nova Scotia can be distributed with sufficient accuracy. January, October, and November give very nearly the same results—about 5.5 inches—and are closely followed by February with an average of 5.4. April, December, March and May give 4.8, 4.6, 4.5, and 4.2, respectively. The normal fall of September is 3.9, of August 3.5, of June 3.4, and July is decidedly the driest month, with 2.9. It will be at once noticed how comparatively dry our Summer is; and that, dividing the year into two equal periods, the six months from 30th September to 31st March, yield 30 inches out of the normal annual 53, leaving 23 only for the warmer months. Or, going farther, and taking the four Winter months of December, January, February, and March, we find twenty inches in them; twenty inches also in the four Spring and Autumn months of April, May, October, and November, and only about thirteen during the remaining third, June, July, August, and September. Of the whole yearly precipitation, about 44.5 inches fall as rain, and the melted snow measures about 8.5 inches more, being the product of seven feet fallen frozen. The above figures are most applicable to Halifax and the Atlantic coast, but the yearly amount does not differ materially from this on the Gulf or Bay Shores, or Inland. The differences by season in the interior are a slightly heavier rain fall in Summer, and a little greater snow depth in winter, balanced by not quite so much rain water in Spring and Autumn. I find that the years of most snow and rain make the soil of Nova Scotia most productive, and are most satisfactory to our farmers, provided that the haymaking and harvest seasons are not wet. There are good reasons for both of these conclusions. A thick layer of snow from the beginning of December to the end of March, prevents the frost from striking very deeply into the ground; the ammonia of the rain and melting snow, combining with the salts of the soil, enables it to nourish the coming roots and grass; and the continuance of good

sledding facilitates, the hauling out of all kinds of wood. April is better dry till the Spring ploughing and planting are over, but then we can stand a large quantity of rain till the middle of June, for proverbially, "a wet May makes good hay." From that date, till August is half gone, much rain is not needed, but the after crop needs moisture then; and through September frequent and copious showers do the pastures more good than they can do harm in other ways. On all accounts, we are better off for a large rain fall in October and November, and we usually are blessed by it. Thus the swamps are filled, and freeze earlier and harder for the Winter's work; and the brooks and rivers running high suit another great branch of the country's industry—lumbering. Indeed the labours of the woodsman, and of the mills are benefitted by rain at all times in this Province where evaporation is so great from March to October.

Of the four oldest provinces of Canada, the total precipitation of Nova Scotia is decidedly the greatest, as is the rain fall. As yet, the observations in British Columbia, Manitoba, and Prince Edward Island, are not numerous enough to place their averages in proper order; but, for the sake of comparison, calling Nova Scotia 40, New Brunswick would be 35, Quebec 26, and Ontario 23. In the latter Province so little rain falls (except in the W. and S. W. district) that frequently the draughts are injurious; and in Toronto, the facts prove that their already limited supply is decreasing, which causes much apprehension. Our large precipitation would be troublesome, did it come in smaller quantities on many days; but this is not so, and we enjoy the farther advantage of having a great number of fair days. Thus Toronto, with an average fall of only 35.5 inches, scores but 186 fair days, while Halifax, with 53 inches rain and melted snow, has still an average of 204 days completely dry. Again, to show how free this Province is is from the light drizzling rains common in many other parts of the north temperate zone: the average rain fall of the London district for 60 years is about 24.5 inches,—less than half of our total precipitation, while the number of wholly dry days is very much the same in any year.

GENERAL METEOROLOGICAL REGISTER FOR 1876.

HALIFAX, NOVA SCOTIA.

Latitude 44° 39′ 20″ North. Longitude 63° 36′ 40″ West. Height above Sea-level 122.5 feet.

OBSERVED BY FREDERICK ALLISON.

1876.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	YEAR-1876.
Mean Temperature	21.74	22.81	28.87	36.30	45.36	60.40	63.80	64.29	54.12	45.49	38.67	22.84	42.06
Difference from Normal (14 years)	-0.88	+0.17	+0.47	+1.11	-2.02	+1.62	+0.57	+0.89	-2.90	-2.56	+1.61	-2.68	-0.56
Maximum Temperature	48.6	48.0	51.0	56.6	70.0	84.8	86.7	90.2	72.2	70.0	62.8	43.0	90.2
Minimum Temperature	-8.8	-16.9	7.1	19.6	29.9	36.2	49.2	46.4	37.2	27.0	18.1	-1.0	-16.9
Monthly and Annual Ranges	57.4	64.9	43.9	37.0	41.1	48.6	37.5	43.8	35.0	43.0	44.7	44.0	107.1
Mean Maximum Temperature	31.10	33.15	36.93	45.06	55.76	71.92	74.99	77.52	64.54	54.36	44.33	30.28	51.66
Mean Minimum Temperature	10.33	11.53	20.85	29.08	36.42	51.64	55.64	54.45	45.34	37.77	33.51	14.25	33.40
Highest Daily Mean Temperature	40.21	38.48	40.52	42.20	56.52	72.51	71.72	75.14	62.71	58.00	57.25	35.61	75.14
Lowest Daily Mean Temperature	7.51	-6.78	13.30	28.36	35.38	50.05	56.70	53.31	50.10	34.38	23.29	3.12	-6.78
Mean Daily Range of Temperature	20.77	21.62	16.08	15.98	19.34	20.28	19.35	23.07	19.20	16.59	10.82	16.03	18.26
Greatest Daily Range of Temperature	38.6	41.6	26.8	26.5	35.0	37.2	33.8	30.8	30.2	30.9	26.8	33.2	44.6
Mean Pressure Corrected	29.940	29.921	29.898	29.850	29.940	29.995	29.913	29.953	29.941	29.825	29.883	29.743	29.900
Difference from Normal (14 years)	+.160	+.145	+.095	+.107	+.200	+.208	+.123	+.143	+.076	-.005	+.125	-.013	+.112
Maximum Pressure	30.614	30.992	30.484	30.337	30.434	30.343	30.164	30.287	30.494	30.199	30.520	30.519	30.992
Minimum Pressure	29.063	28.774	28.981	29.312	29.219	29.484	29.433	29.591	29.308	29.145	29.288	28.921	28.774
Monthly and Annual Ranges	1.551	2.218	1.503	0.995	1.215	0.859	0.731	0.696	1.186	1.054	1.232	1.598	2.218
Highest Daily Mean Pressure	30.513	30.698	30.404	30.305	30.362	30.315	30.136	30.243	30.423	30.100	30.439	30.290	30.698
Lowest Daily Mean Pressure	29.304	29.165	29.242	29.434	29.346	29.527	29.649	29.687	29.491	29.385	29.344	29.182	29.165
Mean Pressure of Vapour	.112	.112	.138	.176	.243	.462	.488	.480	.341	.256	.219	.114	.262
Mean Relative Humidity	82.9	80.8	83.2	82.0	80.5	87.3	83.3	78.7	81.4	80.1	87.5	85.8	82.79
Mean Amount of Cloud	5.91	5.69	6.83	6.85	6.52	7.42	6.48	3.66	5.05	5.47	7.84	5.34	6.09
Difference from Normal (10 years)	-.32	+.24	+1.01	+.54	-.69	+1.33	+.73	-1.86	-.52	.00	+1.21	-1.11	+.13
Prevalent Direction of Wind	N.W.	N.W.	W.	W.	W.S.W.	S.S.W.	W.S.W.	W.S.W.	W.S.W.	W.N.W.	W.N.W.	N.W.	W.
Mean Velocity of Wind	9.97	11.47	11.35	9.39	8.66	6.07	6.17	6.79	8.47	8.49	10.85	12.75	9.20
Difference from Normal (14 years)	+1.04	+2.21	+1.10	+1.33	+.01	+.45	+1.22	+1.95	+2.35	+1.55	+.45	+4.24	+1.26
Amount of Rain	1.341	3.133	5.774	2.130	4.574	3.384	3.914	1.909	6.094	4.067	7.397	0.618	41.335
Difference from Normal (14 years)	+1.030	+0.077	+2.600	-0.719	+0.475	-0.097	+0.956	-1.618	+2.201	-1.393	+2.386	-2.431	+0.899
Number of Days Rain	7	7	9	15	19	21	17	8	10	13	12	5	143
Difference from Normal (14 years)	0	+1	+4	+5	+4	+6	+6	+3	0	0	0	-4	+17
Amount of Snow	21.10	38.23	5.60	9.95	0.90	0	0	0	0	0.01	inap.	25.58	96.37
Difference from Normal (14 years)	+2.05	+14.47	-10.63	+1.05	+0.28	0	0	0	0	-0.15	-3.88	+8.91	+13.10
Number of Days Snow	13	16	9	6	1	0	0	0	0	1	0	12	58
Difference from Normal (14 years)	+3	+7	-2	0	0	0	0	0	0	-1	-4	+1	+9
Total Precipitation	3.576	6.401	6.329	3.208	4.662	3.384	3.914	1.909	6.094	4.076	7.397	3.164	54.114
Difference from Normal (14 years)	-1.798	+0.984	+1.843	-1.354	+0.556	-0.097	+0.956	-1.618	+2.201	+1.385	+1.956	-1.385	+1.803
Number of Dry Days	13	13	13	10	12	9	14	23	20	17	18	17	179
Difference from Normal (14 years)	+4	-3	-5	-6	-4	-6	-6	+3	0	-2	+3	+3	-22
Number of Auroras	0	2	0	3	0	0	1	1	1	0	1	0	9
" Gales	3	4	4	1	0	0	0	0	0	1	2	6	21
" Fogs	4	0	7	3	10	18	14	2	2	4	1	1	66
" Dews	0	0	0	0	4	10	10	13	11	9	1	0	58
" Hoar Frosts	9	5	6	7	4	0	0	0	0	7	3	9	50
" Thunders	0	0	0	0	1	4	3	3	0	1	1	0	13
" Lightnings	0	0	1	2	2	5	1	6	0	1	1	1	20
" Hails	0	0	0	0	0	0	0	0	0	0	0	0	0
" Rainbows	0	0	0	0	0	4	0	2	1	1	0	0	8
" Lunar Halos	3	2	1	3	1	0	0	1	1	0	3	0	15
" Lunar Coronæ	0	0	0	1	0	0	1	0	0	0	3	1	6
" Solar Halos	0	0	5	2	1	3	0	0	0	1	0	0	12
" Days Sleighing	16	27	9	2	0	0	0	0	0	0	0	23	77

With this comparison I must conclude this paper, already extended beyond my first intention; but, with permission of the Institute, I hope on some future evening to complete these climatic remarks, by noticing the occasional phenomena and periodic events, which, with their causes and effects, contribute largely to our meteorological knowledge, and the probable and possible productions of our country.

Art. VII.—Geology of the Site of the Belleveau Mining Operations.—By Rev. John Burwash, M. A., Communicated by John T. Mellish, M. A.

(*Read May*, 1877.)

I.—Character of the Rocks.

The following paper is compiled from notes of observations made during a visit to the property of the Belleveau Albertite and Oil Company, in July, 1876. I may be allowed to state that my stay was short, and that my opportunity for personal observation was limited; but through the kind attention of Mr. Patrick, the Manager of the Mine, who conducted me to the principal exposures, and gave me the benefit of his knowledge of the locality which he has thoroughly studied, I was able to make a much better use of my time, and to obtain a much better knowledge of these rocks than would otherwise have been possible. I found Mr. Patrick practically well acquainted with the stratigraphy of the Carboniferous series in Nova Scotia, and his opinion of the position and relations of these beds, is well worthy of attention.

The place where the Company have sunk their shaft is situated in the Parish of Dorchester, between Memramcook and Peticodiac Rivers, about a mile from the latter, and about five and one-half miles in a direct line from the Albert Mine. It is, Mr. Patrick informed me, on the same line of upheaval as the latter; that is, taking the general direction of the strike at the Albert Mine, you would come to the Belleveau property.

There are two principal kinds of rock—shales and conglomerates. The shales are very characteristic of all places where veins