## II.—*On the Chemical Composition of certain Rocks from Salisbury Crags, Edinburgh.* By W. Ivison Macadam, F.C.S., F.I.C., Lecturer on Chemistry, and Analytical Chemist, Edinburgh.

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The locality from which the following minerals were obtained has long been the scene of active speculation amongst geologists. The theories advanced have increased in number year by year, and are now legion. Whilst the geologist has been busy accumulating facts as to the presence of certain minerals in the rock masses which go to compose the crags, the chemical composition and analyses seem to have been allowed to lie almost unknown. Considering that chemistry might probably aid in clearing up a few of the difficulties which come in the way of the geologist, by giving him exact data as to the composition of the masses he is working with, I have instituted a series of analyses which will be communicated to the Society in short papers.

The rocks to which this paper refers were obtained from the south half of the crags, and refer to Mr Taylor's "South Vent." Sir James Hall, in the Edinburgh Royal Society "Transactions," published a series of analyses by Dr Kennedy, detailing the results of experiments on the formation of calc spar by compression, but the greenstone spoken of in that paper was obtained from the quarry above Holyrood Palace, and at the north end of the crags.

The first of the samples analysed by me was taken from the vent itself; the second from the rock next to and surrounding the vent; whilst the third analysis shows the course of the main or unaltered rock.

*No.* 1 *Sample.* The rock or plug of the south vent is of a light gray colour, with dark green or black crystals intermixed. It is soft and friable, and is readily pulverized to a light green powder. Specific gravity 2·619. It is evidently an altered greenstone. The powder yields effervescence on treating with an acid.

*No.* 2 *Sample,* or the rock surrounding the vent, is of a much darker colour than the rock of the vent. It is compact and hard, and shows veins and cavities filled with calcite crystals. It gives a gray powder when pulverized. Specific gravity of rock, 2·707. The powder shows effervescence on the addition of acid.

*No. 3 Sample.* The rock mass consists of a hard, dark-green, heavy mineral, with a specific gravity of 2·806. When reduced to powder it has a light-green colour. It is evidently greenstone. The powder effervesces slightly when treated with acid.

The analyses of these three rocks gave as follows, the results being given as percentages:—

| | No. 1. Rock forming Plug of South Vent. | No. 2. Rock lying next to South Vent, and altered. | No. 3. Rock Mass pierced by South Vent, but unaltered. |
|---|---|---|---|
| A. *Soluble in Acids*— | | | |
| Ferric oxide ($Fe_2O_3$), | 12·68 | 13·96 | 20·94 |
| Aluminic oxide ($Al_2O_3$), | 2·18 | 3·36 | 6·38 |
| Calcic oxide (CaO), | 11·37 | 18·65 | 1·86 |
| Magnesic oxide (MgO), | 0·74 | 0·75 | 0·73 |
| Cupric oxide (CuO), | 0·42 | 0·43 | 0·33 |
| Carbonic anhydride ($CO_2$), | 9·34 | 15·08 | 2·86 |
| Soluble silica, | 0·06 | 0·07 | 0·06 |
| Potassic oxide ($K_2O$), Sodic oxide ($Na_2O$), loss, | 2·18 | 1·35 | 0·21 |
| Total soluble in acids, | 38·97 | 53·65 | 33·37 |
| B. *After fusion of the insoluble portion, and treatment for the second time, with Acids*— | | | |
| Ferric oxide ($Fe_2O_3$), | 10·05 | 4·13 | 8·54 |
| Aluminic oxide ($Al_2O_3$), | 8·42 | 5·32 | 4·66 |
| Calcic oxide (CaO), | 3·85 | 0·43 | 3·44 |
| Magnesic oxide (MgO), | 0·33 | 0·03 | 2·86 |
| Potassic and sodic oxides, and loss, | 0·32 | 0·01 | 0·69 |
| Soluble after fusion, | 22·97 | 9·92 | 20·19 |
| Insoluble silica, | 35·74 | 34·97 | 45·38 |
| Moisture, | 2·32 | 1·46 | 1·06 |
| | 100·00 | 100·00 | 100.00 |

These analyses are the average results of several trials which gave figures very close upon each other. The ferric oxide ($Fe_2O_3$) is large, and is evidently present in two forms, part being as an oxide and part as a silicate—the first soluble in acids, the second only soluble after fusion with a flux. The amount of calcic oxide in the "vent" rock, and in the rock lying next to the "vent," is considerable. In the rock composing the "vent," the calcium salt is regularly mixed throughout, but in the rock lying next to the "vent" the calcite crystals and veins are found running through the mass of the rock. This calcic oxide is evidently obtained from the dolomite vein, which forms a stratum below the greenstone. The magnesic oxide (MgO) has been derived from the same source as the lime. Cupric oxide (CuO) is present in small quantity in all of these three samples, but I have not been able as yet to obtain any surface rock from which it could have been derived other than the mass of greenstone. It is present as a soluble compound, for it is entirely contained in the acid solution of the rocks. All of the pieces of these three examples I have yet analysed contain this copper compound, and the proportions vary from a mere trace up to 0·43 per cent.

The remaining three samples with which this paper deals are from strata pierced by the "south vent."

*No.* 4 *Sample* is from a bed of limestone lying under the greenstone. It is of a reddish iron colour, and is somewhat crystalline. When acted upon by acids it effervesces much, and yields a solution with a slight yellow tinge. The specific gravity is 2·637.

*No.* 5 *Sample* was obtained from a bed of sandstone underlying the limestone. It is greenish white in colour, and is close grained. When treated with acids it shows effervescence. Specific gravity, 2·421.

*No.* 6 *Sample* is from the same stratum as No. 5, only taken further from the limestone and nearer the bottom of the bed. It has a slight green tinge of colour, and shows rust marks at parts. When acted on by acids it gives very slight effervescence. Specific gravity, 2·536.

The average results of several analysis of these three minerals yielded the following figures calculated to percentages:—

| | No. 4. Limestone below Greenstone and cut through by South Vent. | | No. 5. Sandstone below and next to the Limestone. | | No. 6. Sandstone below Limestone and lower down in stratum than No. 5. | |
|---|---|---|---|---|---|---|
| A. *Soluble in Acids*— | | | | | | |
| Ferric oxide ($Fe_2O_3$) | 2·28 | | 0·77 | | 0·68 | |
| Aluminic oxide ($Al_2O_3$) . . | 0·38 | | 1·46 | | 1·53 | |
| Calcic oxide (CaO), . | 18·95 | | 9·18 | | 1·14 | |
| Magnesic oxide (MgO), | 11·77 | | 0·19 | | 0·16 | |
| Carbonic anhydride ($CO_2$) . . . | 35·79 | | 5·78 | | 1·20 | |
| Soluble silica, . . | 0·03 | | 0·05 | | 0·04 | |
| Potassic and sodic oxides, and loss, . | 0·51 | | 0·34 | | 0·41 | |
| Total soluble in acids, | | 69·71 | | 17·77 | | 5·16 |
| B. *After fusion of the insoluble portion, and treatment for the second time, with Acids*— | | | | | | |
| Ferric oxide ($Fe_2O_3$), | —— | | 10·98 | | 2·44 | |
| Aluminic oxide ($Al_2O_3$), . . | —— | | 0·03 | | 0·12 | |
| Calcic oxide (CaO), . | —— | | 0·22 | | 1·13 | |
| Magnesic oxide (MgO), . . | —— | | trace | | 0·84 | |
| Potassic and sodic oxides, and loss, . | —— | | trace | | 0·59 | |
| Soluble after fusion, | | | | 11·23 | | 5·12 |
| Insoluble silica, . | | 28·93 | | 69·83 | | 88·68 |
| Moisture, . . | | 1·36 | | 1·17 | | 1·04 |
| | | 100·00 | | 100·00 | | 100·00 |

These results show that No. 4 sample of the limestone below the greenstone, and cut through by the "south vent," is a siliceous dolomite. No. 5 sample, the sandstone below the limestone, and next to it, has evidently been infiltrated from the dolomite stratum, for the analysis shows a considerable proportion of calcic oxide and carbonic anhydride, and the analysis of the same sandstone lower down in the stratum (No. 6 sample) adds weight to this conclusion, for in it the calcic oxide and carbonic anhydride have decreased much in quantity, showing that the lime must have come from a higher bed or stratum.