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1984/38. Evaluation of N. White's analyses of Cambrian volcanic rocks of the West Coast Range, Tasmania

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*Abstract*

Geochemical data are very important in characterising environments of accumulation of volcanic rocks and their associated ore deposits. Beacause of doubts concerning the accuracy of a large body of the available data on Cambrian volcanic rocks from Western Tasmania presented by Noel White, a small proportion of his samples from the Sorell Peninsula have been re-analysed by the Department of Mines and the University of Tasmania. The Department's and the University's analyses are in good agreement and differ significantly from those of Noel White for some important trace elements, suggesting that White's data are not entirely reliable and may be misleading with regard to exploration potential.

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A heavy reliance is placed on analyses of such elements as Zr, Y and V in the characterisation of environments of accumulation of volcanic rocks and their associated ore deposits on the West Coast of Tasmania. Knowledge of the environments of formation of the rock-units allows determination of regions suitable for exploration for ore deposits and the three-dimensional distribution of favourable horizons.

In the course of study of Cambrian volcanics from the Sorell Peninsula a number of whole rock analyses were obtained from the Lucas Creek area. Comparison of these analyses with those from the same area presented in Noel White's thesis (1975) showed that the Department of Mines analyses had generally higher Rb and Zr values. Four of the Department's analyses had Rb (12-47 ppm) and Zr (42-220 ppm) while six of White's analyses had Rb (4-12 ppm) and Zr (0-238 ppm) for rocks with very similar major element chemistry. Since the rocks were collected from very close to the same points, as judged from the sample localities in the thesis, these differences were surprising. The low values for Rb and Zr for these and other analyses of igneous rocks from the Sorell Peninsula were also anomalous as some of the values fell outside the range generally found for rocks of their major element chemistry. Due to the importance of the chemistry of these rocks to the understanding of the geology of the West Coast and the need to know if the chemical data in White's thesis for other west coast areas (approximately 150 analyses) are reliable it was decided to re-analyse nineteen of the rocks from the Sorell Peninsula, since they are of immediate value in our work, using splits from the original rock powders stored at the University of Tasmania.

These analyses have now been completed (table 1) and in order to make a comparison between the Department's and White's analyses the correlation coefficients, best fit straight lines and standard deviations have been calculated for a number of elements (table 2). The Department's analyses are the independent variable ($x$) and White's analyses the dependent variable ($y$). The intersection of the best fit straight line with the $y$ axis is $c$ and its slope is $m$. For perfect agreement between the analyses one would expect a correlation coefficient of 1 and a slope of 1 with $c$ being 0: the standard deviation for both sets of analyses should be the same. Any random effect in the analytical process would tend to increase the standard deviation so that results with the lowest standard deviation would be expected to be the most reliable.

Generally the agreement is good for the two sets of analyses, particularly for the major elements. There are departures from the ideal for the following trace elements Rb, Th, Zr, Nb, Ga, Cu, Y, V and Cr. In all these cases except for the last two the standard deviation of the Department's analyses are lower and thus are considered more reliable. As has been pointed out above, White's values for Rb and Zr for a number of samples fall outside the range that might be expected for rocks of their major element chemistry and at low concentrations are distinctly lower than the Department's analyses. In the case of V and Cr the disagreement between the two sets of results is consistent with V and Cr contamination of the low V and Cr samples of White which would be harder due to higher $SiO_2$ and hence greater quartz content. However, the use of an agate mortar by White for the fine crushing stage precludes contamination during crushing.

In order to further check which set of analyses are more reliable five duplicate trace element analyses were made at the University of Tasmania (table 3). Inspection of this table reveals that there is good agreement between the Department's data and those of the university, thus supporting the doubts expressed about the data in Noel White's thesis. Tables 4 and 5 present the same statistical parameters as for Table 2 calculated for these data. As there are only five samples these parameters are not very significant. However they tend to support the view that the university results are in better agreement with those of the Department of Mines than with those of Noel White's thesis.

In view of the belief in the unreliability of White's analyses of some important elements, White's data should be used with caution in future geochemical evaluations of the volcanic rocks associated with ore deposits on the West Coast.

REFERENCE

WHITE, N.C. 1975. *Cambrian volcanism and mineralisation, south-west Tasmania*. Ph.D. thesis. University of Tasmania : Hobart.

[4 June 1984]

*Table 1. CHEMICAL ANALYSES BY THE DEPARTMENT OF MINES AND BY NOEL WHITE (1975). SPECIMEN NUMBERS FROM WHITE'S THESIS. WHITE'S ANALYSES ARE IN PARENTHESES.*

| | 41507 | | 41508 | | 41509 | | 41513 | | 41514 | | 41516 | | 41517 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 46.44 | (47.08) | 46.77 | (48.02) | 66.42 | (67.04) | 52.08 | (53.40) | 69.66 | (69.86) | 54.47 | (54.61) | 59.41 | (60.27) |
| $TiO_2$ | 2.02 | (2.41) | 0.62 | (0.75) | 0.39 | (0.39) | 0.66 | (0.70) | 0.26 | (0.26) | 0.46 | (0.49) | 0.69 | (0.75) |
| $Al_2O_3$ | 13.13 | (13.31) | 14.29 | (14.51) | 14.58 | (14.81) | 17.18 | (17.72) | 14.60 | (14.39) | 14.55 | (14.54) | 16.07 | (16.53) |
| $Fe_2O_3$ | 14.60 | (14.21) | 11.57 | (11.46) | 6.34 | (6.17) | 9.87 | (9.63) | 4.39 | (4.38) | 10.37 | (9.79) | 8.15 | (8.01) |
| MnO | 0.20 | (0.23) | 0.16 | (0.16) | 0.16 | (0.16) | 0.16 | (0.16) | 0.07 | (0.04) | 0.16 | (0.17) | 0.08 | (0.06) |
| MgO | 6.54 | (6.78) | 8.87 | (9.05) | 0.78 | (0.82) | 4.67 | (4.31) | 0.84 | (0.76) | 6.90 | (7.00) | 2.64 | (2.64) |
| CaO | 8.82 | (8.92) | 10.62 | (10.79) | 0.51 | (0.46) | 4.43 | (4.36) | 0.30 | (0.25) | 3.87 | (4.47) | 1.40 | (1.42) |
| $Na_2O$ | 3.00 | (3.45) | 2.43 | (2.37) | 4.14 | (3.80) | 4.16 | (4.43) | 4.46 | (3.83) | 3.69 | (4.35) | 7.26 | (6.91) |
| $K_2O$ | 1.11 | (1.11) | 1.11 | (1.14) | 4.43 | (4.45) | 2.80 | (2.84) | 4.29 | (4.28) | 1.31 | (1.91) | 2.46 | (2.54) |
| $P_2O_5$ | 0.27 | (0.22) | 0.12 | (0.07) | 0.14 | (0.11) | 0.28 | (0.24) | 0.10 | (0.11) | 0.17 | (0.11) | 0.14 | (0.12) |
| Rb | 12 | (0) | 18 | (0) | 200 | (215) | 39 | (34) | 175 | (186) | 46 | (33) | 24 | (8) |
| Ba | 120 | (180) | 57 | (56) | 920 | (814) | 750 | (680) | 750 | (680) | 970 | (850) | 155 | (145) |
| Sr | 120 | (141) | 230 | (260) | 49 | (52) | 540 | (590) | 44 | (72) | 200 | (238) | 44 | (72) |
| Th | 4 | (6) | 4 | (12) | 22 | (18) | 13 | (5) | 25 | (34) | 15 | (29) | 14 | (25) |
| Zr | 135 | (95) | 31 | (0) | 220 | (229) | 115 | (111) | 180 | (163) | 95 | (52) | 135 | (97) |
| Nb | 6 | (6) | <3 | (0) | 10 | (0) | 4 | (1) | 11 | (9) | 3 | (1) | 4 | (9) |
| V | 390 | (397) | 300 | (299) | 60 | (78) | 210 | (240) | 42 | (70) | 185 | (229) | 190 | (218) |
| Cr | 200 | (198) | 300 | (290) | <5 | (34) | <5 | (35) | <5 | (34) | 155 | (165) | <5 | (27) |
| Ga | 24 | (40) | 11 | (28) | 14 | (17) | 14 | (20) | 12 | (29) | <4 | (25) | 11 | (29) |
| Cu | 280 | (370) | 53 | (70) | 14 | (18) | 22 | (12) | 10 | (3) | 17 | (0) | 12 | (3) |
| Zn | 100 | (79) | 72 | (45) | 83 | (65) | 85 | (70) | 59 | (25) | 36 | (36) | 53 | (23) |
| Y | 25 | (31) | 26 | (31) | 37 | (47) | 27 | (27) | 20 | (35) | 25 | (86) | 23 | (31) |

*Table 1. (continued)*

| | 41524 | | 41525 | | 41527 | | 41530 | | 41531 | | 41536 | | 41567 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 54.95 | (55.68) | 75.25 | (76.14) | 66.83 | (66.69) | 53.44 | (53.72) | 59.52 | (59.89) | 70.59 | (70.82) | 49.98 | (50.47) |
| $TiO_2$ | 0.87 | (0.81) | 0.22 | (0.15) | 0.59 | (0.66) | 0.49 | (0.55) | 0.53 | (0.56) | 0.28 | (0.28) | 1.41 | (1.69) |
| $Al_2O_3$ | 17.20 | (17.04) | 13.65 | (14.02) | 15.42 | (15.80) | 16.93 | (17.18) | 14.30 | (14.44) | 14.28 | (14.76) | 14.26 | (13.99) |
| $Fe_2O_3$ | 13.92 | (13.18) | 1.10 | (1.10) | 4.88 | (5.03) | 9.64 | (9.81) | 7.83 | (7.96) | 3.21 | (3.08) | 12.52 | (12.41) |
| MnO | 0.16 | (0.12) | 0.08 | (0) | 0.04 | (0.01) | 0.23 | (0.24) | 0.13 | (0.11) | 0.06 | (0.04) | 0.15 | (0.18) |
| MgO | 3.07 | (2.69) | 0.25 | (0.28) | 0.10 | (0.22) | 4.87 | (4.79) | 4.26 | (4.03) | 0.76 | (0.71) | 5.93 | (6.09) |
| CaO | 0.27 | (0.24) | 0.02 | (0.01) | 0.26 | (0.24) | 3.25 | (3.19) | 5.11 | (5.02) | 0.33 | (0.27) | 8.28 | (8.43) |
| $Na_2O$ | 5.40 | (6.48) | 3.89 | (3.28) | 3.88 | (3.54) | 3.51 | (3.82) | 3.07 | (2.89) | 4.56 | (3.93) | 3.55 | (4.13) |
| $K_2O$ | 0.09 | (0.09) | 3.75 | (3.64) | 6.05 | (6.06) | 4.26 | (4.32) | 2.68 | (2.71) | 4.65 | (4.70) | 0.47 | (0.50) |
| $P_2O_5$ | 0.17 | (0.17) | 0.03 | (0.04) | 0.20 | (0.21) | 0.19 | (0.16) | 0.13 | (0.09) | 0.07 | (0.07) | 0.21 | (0.16) |
| Rb | 7 | (0) | 128 | (141) | 140 | (143) | 125 | (118) | 125 | (118) | 160 | (169) | 15 | (8) |
| Ba | 15 | (40) | 720 | (620) | 2600 | (2510) | 1500 | (1340) | 650 | (594) | 890 | (798) | 210 | (232) |
| Sr | 38 | (40) | 44 | (72) | 105 | (130) | 230 | (265) | 240 | (267) | 115 | (140) | 300 | (312) |
| Th | 15 | (4) | 32 | (53) | 28 | (41) | 14 | (34) | 13 | (27) | 23 | (42) | <3 | (2) |
| Zr | 150 | (128) | 135 | (128) | 220 | (200) | 84 | (52) | 185 | (166) | 110 | (96) | 95 | (62) |
| Nb | 8 | (11) | 8 | (4) | 13 | (9) | <3 | (0) | 5 | (10) | 10 | (12) | 4 | (0) |
| V | 195 | (202) | 16 | (52) | 110 | (126) | 240 | (267) | 155 | (193) | 43 | (76) | 380 | (402) |
| Cr | <5 | (18) | <5 | (27) | <5 | (31) | 5 | (38) | 105 | (144) | <5 | (36) | 115 | (146) |
| Ga | 18 | (23) | 13 | (27) | 13 | (27) | 17 | (27) | 12 | (24) | 13 | (27) | 13 | (19) |
| Cu | 5 | (0) | 7 | (0) | 14 | (0) | 19 | (18) | 13 | (6) | 9 | (0) | 110 | (175) |
| Zn | 77 | (68) | 15 | (0) | 18 | (0) | 69 | (34) | 61 | (27) | 100 | (76) | 85 | (80) |
| Y | 25 | (24) | 12 | (22) | 25 | (34) | 19 | (31) | 27 | (39) | 24 | (35) | 26 | (23) |

*Table 1. (continued)*

| | 41569 | | 41570 | | 41571 | | 41572 | | 41575 | |
|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 47.80 | (47.81) | 48.16 | (49.10) | 50.07 | (50.95) | 43.38 | (44.61) | 44.11 | (44.80) |
| $TiO_2$ | 3.14 | (3.10) | 1.52 | (1.82) | 0.91 | (1.02) | 0.38 | (0.44) | 0.58 | (0.71) |
| $Al_2O_3$ | 12.67 | (13.60) | 14.51 | (14.96) | 13.34 | (12.95) | 12.38 | (12.23) | 13.21 | (13.42) |
| $Fe_2O_3$ | 15.25 | (14.76) | 12.55 | (12.29) | 12.82 | (12.57) | 7.86 | (8.00) | 11.59 | (11.52) |
| MnO | 0.22 | (0.20) | 0.16 | (0.17) | 0.22 | (0.19) | 0.12 | (0.12) | 0.16 | (0.17) |
| MgO | 5.82 | (5.66) | 6.97 | (7.14) | 7.93 | (8.01) | 9.80 | (9.60) | 14.06 | (13.66) |
| CaO | 8.01 | (7.91) | 9.38 | (9.60) | 7.60 | (7.54) | 11.92 | (11.12) | 9.49 | (10.02) |
| $Na_2O$ | 3.23 | (3.73) | 2.41 | (2.74) | 2.74 | (3.49) | 2.76 | (3.65) | 1.06 | (1.23) |
| $K_2O$ | 0.54 | (0.53) | 1.03 | (1.04) | 0.37 | (0.37) | 0.70 | (0.72) | 0.79 | (0.81) |
| $P_2O_5$ | 0.38 | (0.33) | 0.21 | (0.16) | 0.14 | (0.12) | 0.10 | (0.06) | 0.12 | (0.07) |
| Rb | 17 | (8) | 23 | (12) | 12 | (4) | 14 | (5) | 23 | (9) |
| Ba | 195 | (274) | 410 | (423) | 110 | (130) | 330 | (327) | 300 | (267) |
| Sr | 300 | (310) | 250 | (264) | 180 | (194) | 120 | (136) | 66 | (72) |
| Th | 3 | (6) | 5 | (0) | 4 | (0) | <3 | (0) | <3 | (0) |
| Zr | 220 | (238) | 99 | (63) | 71 | (78) | 15 | (0) | 37 | (0) |
| Nb | 11 | (7) | 3 | (0) | 4 | (0) | <3 | (0) | <3 | (0) |
| V | 460 | (189) | 330 | (358) | 300 | (320) | 150 | (202) | 210 | (262) |
| Cr | 82 | (113) | 195 | (190) | 300 | (300) | 1000 | (1000) | 1350 | (1300) |
| Ga | 22 | (26) | 20 | (23) | 13 | (16) | 7 | (11) | 12 | (16) |
| Cu | 115 | (146) | 110 | (146) | 105 | (134) | 32 | (33) | 72 | (330) |
| Zn | 130 | (118) | 110 | (102) | 86 | (65) | 48 | (41) | 81 | (64) |
| Y | 39 | (56) | 26 | (24) | 25 | (40) | 14 | (11) | 17 | (16) |

*Table 2. STATISTICAL DATA DERIVED FROM A COMPARISON OF NOEL WHITE'S AND DEPARTMENT OF MINES ANALYSES*

| Element | r | c | m | s.d. Noel White | s.d. Department of Mines | Noel White lower limits of detection |
|---|---|---|---|---|---|---|
| $SiO_2$ | 0.999 | 1.539 | 0.9834 | 9.62 | 9.78 | |
| $TiO_2$ | 0.989 | 0.026 | 1.0642 | 0.78 | 0.73 | |
| $Al_2O_3$ | 0.976 | -0.048 | 1.0165 | 1.50 | 1.44 | |
| $Fe_2O_3$ | 0.999 | 0.186 | 0.963 | 3.88 | 4.03 | |
| MnO | 0.945 | -0.041 | 1.2188 | 0.07 | 0.06 | |
| MgO | 0.999 | -0.002 | 0.9918 | 3.70 | 3.72 | |
| CaO | 0.998 | 0.027 | 0.9988 | 4.16 | 4.16 | |
| $Na_2O$ | 0.913 | 0.555 | 0.8886 | 1.27 | 1.30 | |
| $K_2O$ | 0.997 | 0.066 | 0.9912 | 1.81 | 1.82 | |
| $P_2O_5$ | 0.957 | -0.006 | 0.8613 | 0.07 | 0.08 | |
| Rb | 0.997 | -13.556 | 1.1271 | 75.67 | 66.97 | 2 |
| Ba | 0.995 | 6.717 | 0.919 | 577.99 | 625.81 | 4.1 |
| Sr | 0.996 | 14.065 | 1.0450 | 133.79 | 127.57 | 2.8 |
| Th | 0.872 | -0.557 | 1.4897 | 17.21 | 10.07 | 5.9 |
| Zr | 0.974 | -34.571 | 1.1213 | 72.06 | 62.63 | 4.5 |
| Nb | 0.664 | 0.140 | 0.7341 | 4.61 | 4.17 | 2.7 |
| V | 0.835 | 72.626 | 0.7060 | 107.24 | 126.80 | 2.5 |
| Cr | 0.999 | 25.131 | 0.9504 | 344.36 | 362.09 | 3.8 |
| Ga | 0.418 | 16.261 | 0.554 | 6.46 | 4.88 | 3.7 |
| Cu | 0.871 | -0.701 | 1.450 | 113.29 | 68.03 | |
| Zn | 0.946 | -19.676 | 1.017 | 31.89 | 29.66 | 4.3 |
| Y | 0.524 | 1.778 | 1.3186 | 16.37 | 6.51 | 1.9 |

s.d. = standard deviation.

*Table 3. SELECTED TRACE ELEMENT ANALYSES BY THE UNIVERSITY OF TASMANIA, NOEL WHITE AND THE DEPARTMENT OF MINES.*

| | 41508 | | | 41509 | | | 41514 | | | 41517 | | | 41525 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Uni. Tas. | N.White (BHP) | Mines | Uni. Tas. | N.White (BHP) | Mines | Uni. Tas. | N.White (BHP) | Mines | Uni. Tas. | N.White (BHP) | Mines | Uni. Tas. | N.White (BHP) | Mines |
| Rb | 16 | 0 | 18 | 207 | 215 | 200 | 183 | 186 | 175 | 22 | 8 | 24 | 134 | 141 | 128 |
| Ba | 54 | 56 | 57 | 851 | 814 | 920 | 689 | 650 | 750 | 126 | 145 | 155 | 685 | 620 | 720 |
| Sr | 239 | 260 | 230 | 48 | 52 | 49 | 45 | 72 | 44 | 47 | 72 | 44 | 47 | 72 | 44 |
| Zr | 38 | 0 | 31 | 226 | 229 | 220 | 182 | 163 | 180 | 144 | 97 | 135 | 139 | 128 | 135 |
| Nb | 3 | 0 | <3 | 14 | 0 | 10 | 14 | 9 | 11 | 9 | 9 | 4 | 12 | 4 | 8 |
| V | 344 | 299 | 300 | 59 | 78 | 60 | 43 | 70 | 42 | 216 | 218 | 190 | 13 | 52 | 16 |
| Cr | 328 | 290 | 300 | 3 | 34 | <5 | 5.5 | 34 | <5 | <2 | 27 | <5 | <2 | 27 | <5 |
| Y | 28 | 31 | 26 | 40 | 47 | 37 | 23 | 35 | 20 | 26 | 31 | 23 | 14 | 22 | 12 |
| Ni | 150 | 138 | 135 | 4 | 10 | 3 | 5 | 12 | 3 | 10 | 10 | 7 | 2 | 2 | <3 |
| La | 3 | 74 | n.d. | 28 | 27 | n.d. | 35 | 36 | n.d. | 26 | 14 | n.d. | 48 | 38 | n.d. |
| Ce | <5 | 0 | n.d. | 48 | 20 | n.d. | 70 | 30 | n.d. | 58 | 50 | n.d. | 94 | 70 | n.d. |

Uni.Tas. March 1984, Geology Department, University of Tasmania. n.d. not determined
N. White Ph.D. thesis (analysis at B.H.P. laboratories) 1975.
Mines Tasmanian Department of Mines Laboratory Launceston, 1983.

Note: The same powder was not used by each laboratory. Splits from the same jaw crushed material were taken by each laboratory and pulverised either in a tungsten carbide mill (University and Tasmanian Department of Mines) or in an automatic agate pestle and mortar (N. White).

*Table 4. STATISTICAL DATA DERIVED FROM A COMPARISON OF NOEL WHITE'S AND UNIVERSITY OF TASMANIA DATA.*

| Element | r | c | m | s.d. Noel White | s.d. Univ. of Tas. |
|---|---|---|---|---|---|
| Rb | 0.999 | -16.255 | 1.1233 | 100.33 | 89.25 |
| Ba | 0.999 | 14.707 | 0.9195 | 335.19 | 364.05 |
| Sr | 0.994 | 20.153 | 1.0029 | 86.75 | 85.98 |
| Zr | 0.984 | -51.005 | 1.1962 | 84.65 | 69.66 |
| Nb | -0.084 | 3.357 | -0.0728 | 3.97 | 4.62 |
| Cr | 1.000 | 28.798 | 0.7965 | 116.10 | 145.75 |
| Y | 0.933 | 9.599 | 0.9008 | 9.07 | 9.39 |
| Ni | 0.998 | 3.814 | 0.8943 | 58.04 | 64.80 |

*Table 5. STATISTICAL DATA DERIVED FROM A COMPARISON OF DEPARTMENT OF MINES AND UNIVERSITY OF TASMANIA DATA.*

| Element | r | c | m | s.d. Dept. of Mines | s.d. Univ. of Tas. |
|---|---|---|---|---|---|
| Rb | 1.000 | 2.703 | 0.9457 | 84.42 | 89.25 |
| Ba | 0.999 | 8.749 | 1.0637 | 387.46 | 364.05 |
| Sr | 1.000 | 0.319 | 0.9610 | 82.65 | 85.98 |
| Zr | 0.999 | -7.436 | 1.0126 | 70.59 | 69.66 |
| Nb | 0.983 | -3.507 | 0.9718 | 4.56 | 4.62 |
| Cr | 1.000 | -1.941 | 0.9204 | 134.16 | 145.75 |
| Y | 0.999 | -1.828 | 0.9705 | 9.13 | 9.39 |
| Ni | 1.000 | -1.523 | 0.9100 | 58.97 | 64.80 |

s.d. = standard deviation.