PETROGRAPHY OF SOME SOUTH VICTORIA LAND ROCKS

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ABSTRACT

A petrographic quantitative study has been made of the mineral composition of certain igneous intrusive rocks of South Victoria Land, Antarctica, and comparisons made between these rocks and those examined from other Antarctic lands.

INTRODUCTION

Forty-five specimens of Antarctic rocks and minerals have been added recently to the collections of the University of Michigan[1] through the courtesy of Dr. W. Campbell Smith of the British Museum. These samples were collected by Mr. Frank Debenham and Mr. R. E. Priestley, of the British Antarctic *Terra Nova* Expedition, 1910–13, in the vicinity of Granite Harbour, approximately Latitude 77° South, Longitude 162° East, and Terra Nova Bay, approximately Latitude 75° South, Longitude 164° East, South Victoria Land (Fig. 1).

Fourteen specimens are referred to, or have been reported on briefly, by Smith.[2] Of these, quantitative mineralogical data for five (D11G, D56G, D85G, D104G and 1966) are recorded in this paper. Three other reports[3,4,5] of the *Terra Nova* Expedition were helpful in the compilation of the results of this research. Still other references on the petrography of South Victoria Land rocks are those of Benson,[6] Prior,[7] Rastall and Priestley,[8] Schetelig,[9] and Stewart.[10]

[1] Stewart, Duncan, Jr., The University of Michigan collections of Antarctic rocks and minerals: *Proc. Am. Philosophical Soc.*, **74,** No. 4, 311–317 (1934).

[2] Smith, W. Campbell, The plutonic and hypabyssal rocks of South Victoria Land: British Antarctic ("Terra Nova") Expedition, 1910, Natural History Report, *Geology*, Vol. I, No. 6, 167–227, British Museum (Natural History) (**1924**).

[3] Debenham, F., The sandstone, etc., of the McMurdo Sound, Terra Nova Bay, and Beardmore Glacier regions. The sedimentary rocks of South Victoria Land: *Ibid.*, No. **4a,** 101–119 (1921).

[4] Smith, W. Campbell, and Debenham, F., The metamorphic rocks of the McMurdo Sound region. The metamorphic rocks of South Victoria Land: *Ibid.*, No. **5a,** 131–144 (1921).

[5] Smith, W. Campbell, and Priestley, R. E., The metamorphic rocks of the Terra Nova Bay region: *Ibid.*, No. **5b**, 145–165 (1921).

[6] Benson, W. N., Chapman, F., Cohan, Miss F., Cotton, L. A., and Others, Contributions to the palaeontology and petrology of South Victoria Land: British Antarctic Expedition, 1907–9, under the Command of Sir E. H. Shackleton, *Reports of Scientific Investigations, Geology*, Vol. II, 270 pp., William Heinemann, London (**1916**).

[7] Prior, G. T., Report on the rock specimens collected during the 'Discovery' Antarctic Expedition, 1901–4: National Antarctic Expedition, 1901–4, Natural History, Vol. I, *Geology* (Field-Geology: Petrography), 101–140, British Museum (Natural History) (**1907**).

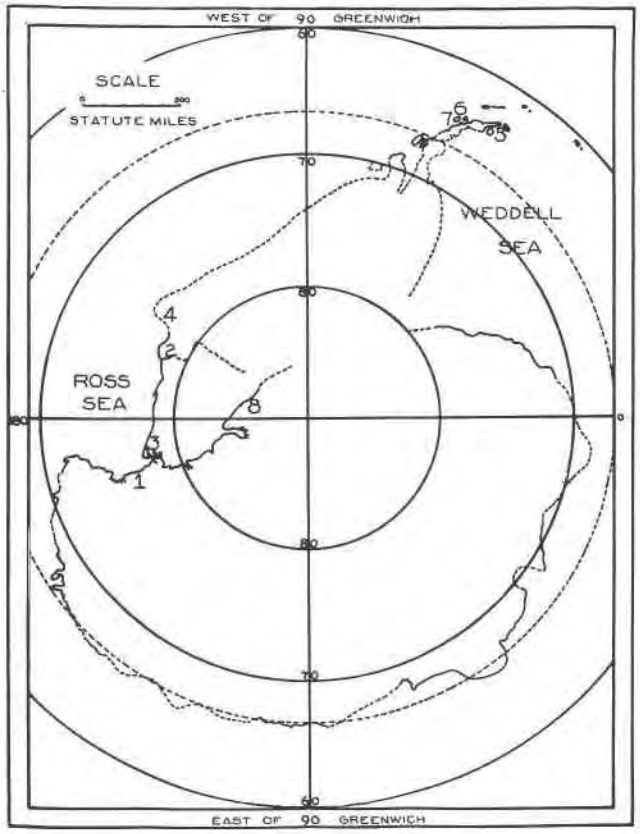

FIG. 1. Sketch map of Antarctica showing the distribution of collection localities.

1. Granite Harbour and Terra Nova Bay, South Victoria Land.
2. Rockefeller Mountains, King Edward VII Land.
3. Ross Island, South Victoria Land.
4. Edsel Ford Range, Marie Byrd Land.
5. Hope Bay, Louis Philippe Land, West Antarctica.
6. Localities of the Expédition Antarctique Française and the Expédition Antarctique Belge, West Antarctica.
7. *Ibid.*
8. Queen Maud Mountains, South Victoria Land.

[8] Rastall, R. H., and Priestley, R. E., The slate-greywacke formation of Robertson Bay. The sedimentary rocks of South Victoria Land: British Antarctic ("Terra Nova") Expedition, 1910, Natural History Report, *Geology*, Vol. I, No. 4b, 121–129, British Museum (Natural History) (**1921**).

[9] Schetelig, J., Report on the rock specimens collected on Roald Amundsen's South Pole Expedition: *Videnskapsselskapets Skrifter, I, Mat. -naturv Klasse*, No. 4, 1–31, Christiana (1915).

[10] Stewart, Duncan, Jr., The petrography of the Beacon sandstone of South Victoria Land: *Am. Mineral*, **19**, 351–359 (1934).

TABLE 1. MINERALOGICAL COMPOSITION OF SOME ROCKS FROM SOUTH VICTORIA LAND

Mineral	Specimen																	
	1383*	1600*	1422	1648	D11G	1568	1573	1966	1592	D71G*	1424	D104G	D56G*	D21G	1328	1346	1722	1740	D85G
Quartz	36.62	32.46	30.90	30.48	29.18	28.73	27.10	18.59	18.26	14.04	12.75	5.91	0.22	p	—	63.63	36.34	30.19	19.00
K-feldspar	47.53	29.06	37.55	p	30.44	30.01	0.42	32.69	16.60	p	—	5.71	74.13	67.20	—	—	26.57	18.69	—
Oligoclase	—	33.38	24.73	65.16	34.33	—	51.08	36.01	36.66	58.73	—	46.31		12.01	—	—	—	25.67	—
Albite	3.68	—	—	—	—	36.11	—	—	—	—	—	—	—	—	—	—	—	—	—
Andesine	—	—	—	—	—	—	—	—	—	—	42.12	—	—	—	44.32	22.20	—	—	—
Plagioclase	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20.60	—	—
Biotite, chlorite	p	4.63	4.48	3.97	6.05	3.54	20.64	12.49	20.84	2.87	17.55	39.70	21.42	—	15.86	12.25	15.55	23.76	—
Green hornblende	—	—	—			—			3.56	22.82	26.17			—	36.07	—	—	—	—
Diopside	—	—	—	—	—	—	—	—	—	—	p	—	—	3.94	—	—	—	—	49.34
Wollastonite	—	—	—	—	—	—	—	—	—	—	—	—	—	5.48	—	—	—	—	—
Vesuvianite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3.27
Mizzonite	—	—	—	—	—	—	—	—	—	—	—	—	—	6.56	—	—	—	—	—
Prehnite (?)	—	—	—	—	—	—	—	—	—	—	—	—	p	—	—	—	—	—	—
Muscovite	10.40	p	p	p	p	p	p	p	—	p	p	p	p	—	—	p	p	p	—
Apatite	—	p	p	p	p	p	p	p	p	p	p	p	p	p	p	—	p	p	—
Zircon	—	p	p	p	p	p	p	p	p	p	p	—	p	—	p	p	p	p	—
Iron "ores"	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	—
Sphene	—	p	—	—	p	—	p	—	3.23	p	p	p	p	p	p	p	p	p	p
Epidote	—	p	p	—	p	—	—	—	p	—	—	p	—	—	—	p	p	—	—
Zoisite	—	—	—	p	—	—	—	—	p	p	p	—	—	—	p	—	—	—	—
Cassiterite	p	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?	—	—
Tourmaline	1.76	—	p	—	—	p	—	—	—	—	—	—	—	—	—	—	—	—	—
Topaz	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	p	—	—	—
Rutile (?) needles	—	p	p	—	—	p	p	p	p	p	p	—	—	—	—	p	p	p	p
Apatite (?) needles	p	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	p
Allanite (?)	—	p	—	—	p	—	—	—	p	p	—	—	—	—	—	—	—	—	—
Calcite	—	—	p	—	—	—	p	p	—	—	p	—	p	4.81	—	—	—	p	28.39
Leucoxene	—	—	—	—	—	—	—	—	—	—	p	—	—	—	—	p	—	—	—
Kaolin	p	—	p	p	p	p	p	p	p	p	—	p	p	p	—	—	p	p	—
Sericite	—	—	p	p	p	p	p	p	p	p	p	p	p	—	—	p	p	p	—
Accessories	—	0.46	2.34	0.39	—	1.61	0.77	0.21	0.86	1.52	1.41	2.37	4.22	—	3.75	1.92	0.93	1.69	—
	99.99	99.99	100.00	100.00	100.00	100.00	100.01	99.99	100.01	99.98	100.00	100.00	99.99	100.00	100.00	100.00	99.99	100.00	100.00

* Average of two sections.

1383. Kalialaskite. Terra Nova Bay.
1600. Leucoadamellite with angular fragments of microdiorite. Vegetation Island, Terra Nova Bay.
1422. Leucoadamellite. Erratic. Northern Foothills, Terra Nova Bay.
1648. Leucotonalite. Erratic. Boomerang-Campbell Moraine, Terra Nova Bay.
D11G. Adamellite. Devil's Punchbowl, Granite Harbour.
1568. Leuco-sodaclase-adamellite. Erratic. Hell's Gate Moraine, Terra Nova Bay.
1573. Tonalite. Erratic. Hell's Gate Moraine, Terra Nova Bay.
1966. Adamellite. Erratic. Hell's Gate Moraine, Terra Nova Bay
1592. Monzotonalite. Vegetation Island, Terra Nova Bay.
D71G. Tonalite. Cape Geology, Granite Harbour.
1424. Tonalite. Northern Foothills, Terra Nova Bay.
D104G. Monzotonalite. In talus below Devil's Thumb, Devil's Punchbowl, Granite Harbour.
D56G. Syenodiorite. Talus slope of Discovery Bluff, Granite Harbour.
D21G. Syenite. Marble Dike, The Flatiron, Granite Harbour.
1328. Meladiorite. Erratic. Priestley Glacier (?), Terra Nova Bay.
1346. Tonalite gneiss. Erratic. Evans Coves, Terra Nova Bay.
1722. Porphyritic adamellite gneiss. Erratic. Eastern Moraine, Corner Glacier, Terra Nova Bay.
1740. Adamellite gneiss. Erratic. Eastern Moraine, Corner Glacier, Terra Nova Bay.
D85G. Contact rock. Marble Dike, The Flatiron, Granite Harbour.

Twenty-seven of the specimens represent igneous rocks, eight are sedimentary, eight metamorphic, and two are minerals. Twenty-two of these specimens are labeled erratics. Forty-four thin sections have been examined and twenty-three quantitative mineralogical analyses have been made with the improved Wentworth recording micrometer. An aggregate distance of some 51,000 units was measured in traversing each section, an average of seventeen times. Quantitative results from thin sections of fifteen igneous and four metamorphic rocks are recorded in Table 1.

Acknowledgments

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Characteristics of the Rocks

The fifteen intrusive rocks vary in composition from kalialaskite to meladiorite. The metamorphic rocks include three gneisses and one contact rock. The presence of cassiterite in small quantities in sections of specimen 1383, a kalialaskite, is of interest because of the scarcity of references to metallic minerals in Antarctic rocks. Cassiterite (?) has been previously noted by the author in acid intrusives from the Rockefeller Mountains, King Edward VII Land.

Antiperthite, small patches of K-feldspar in acid plagioclase, is recorded in sections 1568, 1573, 1722 and 1966. Strain shadows are observed in the quartz of six sections, and bent plagioclase twinning lamellae in eight sections of the intrusives. This apparent characteristic of some South Victoria Land basement intrusive rocks has been referred to by Mawson,[11] Prior,[12] Smith,[13] and Woolnough.[14]

[11] Mawson, D., Petrology of rock collections from the mainland of South Victoria Land. Contributions to the palaeontology and petrology of South Victoria Land: British Antarctic Expedition, 1907–9, under the Command of Sir E. H. Shackleton, *Reports of Scientific Investigations, Geology*, Vol. II, Part XIII, 201–234 (1916).

[12] Prior, G. T., *op. cit.*, 126.

[13] Smith, W. Campbell, *op. cit.*, 169.

[14] Woolnough, W. G., Petrological notes on some erratics collected at Cape Royds. Contributions to the palaeontology and petrology of South Victoria Land: British Antarctic Expedition, 1907–9, under the command of Sir E. H. Shackleton, *Reports of Scientific Expeditions, Geology*, Vol. II, Part XI, 169–188 (1916).

In ten intrusive specimens zoning of the plagioclase feldspars is apparent. In eleven, micrographic intergrowths of quartz and feldspar are recorded, and in seven sections both zoned plagioclase and micrographic intergrowths occur. Reference to such an association is made by Woolnough[15] in a description of a quartz diorite erratic collected at Cape Royds, Ross Island, South Victoria Land. In a publication by Mawson[16] the association of zoned plagioclase and micrographic intergrowths is not mentioned in the study of rocks collected at Cape Irizar and certain other localities on the mainland of South Victoria Land.

Discussion

According to Nordenskjöld,[17] the plagioclase feldspars of the intrusives of the Hope Bay area, Louis Philippe Land, West Antarctica, exhibit zoning, and at times micrographic intergrowths of quartz and orthoclase. In a discussion,[18] resulting from a study of 107 rocks collected by Nordenskjöld's Swedish Antarctic Expedition, 1901–03, this occurrence was noted in certain intrusive rocks, and the occurrence of fragments of micrographic intergrowths in certain sedimentary rocks, most probably derived from the igneous rocks, was recorded. The studies of Gourdon[19] indicate a great similarity between the intrusive rocks collected by the Expédition Antarctique Française, the Swedish Antarctic Expedition and the Expédition Antarctique Belge,[20,21] all from West Antarctica.

Wade,[22] in referring to the intrusives of the Edsel Ford Range, remarks: "The eruptives of northwest Marie Byrd Land are high in sodium and potassium and are in this respect analogous to those of East Antarctica. However, the presence of zoned plagioclase in many of the intrusives suggests a relationship with rocks of West Antarctica." A preliminary examination of Wade's thin sections of thirty-six acid intrusives from northwest Marie Byrd Land indicates that some seventy-five per

[15] Woolnough, W. G., *op. cit.*, 173.

[16] Mawson, D., *op. cit.*,

[17] Nordenskjöld, Otto, Petrographische Untersuchungen aus dem westantarktischen Gebiete: *Upsala Univ. Geol. Inst. Bull.*, 1902–1903, **6**, 237 (1905).

[18] Stewart, Duncan, Jr., Petrography of some rocks from the South Orkney Islands and the Antarctic Archipelago: *Am. Mineral.*, **22**, 186 (1937).

[19] Gourdon, E., Géographie Physique.—Glaciologie.—Pétrographie des Régions visitées par l'Expédition Antarctique Française commandée par le Dr. Charcot (1903–05), p. 205, Paris (**1908**).

[20] Pelikan, A., Géologie, Petrographische Untersuchung der Gesteinsproben: Expédition Antarctique Belge, Résultats du Voyage du S.Y. Belgica en 1897–1898–1899 sous, le commandement de A. de Gerlache de Gomery, *Rapports Scientifiques*, Theil I, 49 pp. Anvers (**1909**).

[21] Sistek, Dragomir, *Ibid.*, Theil II, 29 pp. (**1912**).

[22] Wade, F. A., Petrologic and structural relations of the Edsel Ford Range, Marie Byrd Land, to other Antarctic mountains: *Bull. Geol. Soc. Amer.*, **48**, 1394 (1937).

cent contain zoned plagioclase feldspars, thirty-five per cent micrographic intergrowths, and approximately thirty-five per cent exhibit both zoned plagioclase and micrographic intergrowths.

The examination of the *Terra Nova* rocks shows that there is some petrographical similarity between certain South Victoria Land, Marie Byrd Land and West Antarctica specimens, inasmuch as there are zoned plagioclase feldspars associated with micrographic intergrowths in a number of the intrusives.

Schetelig,[23] after a comparative study of granite, diorite and granodiorite from West Antarctica and Scott's Nunatak, King Edward VII Land, concluded that the rocks of the two regions are not similar. Bodman[24] examined rocks from Scott's Nunatak, King Edward VII Land, and Mount Betty, Queen Maud Mountains, South Victoria Land, and found that they possessed characteristics different from those of the rocks of West Antarctica.

After comparative studies of Gould's[25] specimens from King Edward VII Land with specimens from the Queen Maud Mountains of South Victoria Land and with rocks collected by the Expédition Antarctique Française, 1903–05, in West Antarctica, the author[26] concluded that the rocks of the Rockefeller Mountains have close affinities with the high sodium- and potassium-bearing rocks of East Antarctica, and show little affinity with the high calcium-, magnesium-, and iron-bearing rocks of the Andes of South America and West Antarctica. The rocks of the Rockefeller Mountains do not exhibit zoned plagioclase feldspars in thin section, and moreover, the feldspars of the specimens from the Queen Maud Mountains, described by Stewart,[27] lack zonary banding.

Conclusions

It is suggested that the intrusives of West Antarctica, high in calcium, magnesium and iron, and possessing petrographical similarities, as zoning of the plagioclase feldspars and having affinities with the rocks

[23] Schetelig, J., *op. cit.*

[24] Bodman, Gösta, Petrographische Studien über einige antarktische gesteine: Wissenschaftliche Ergebnisse der schwedischen Südpolar-Expedition, 1901–1903, *Geologie und Palaontologie*, Band 3, Lieferung 15, 76–79, Stockholm (1916).

[25] Gould, L. M., Some geographical results of the Byrd Antarctic Expedition: *Geog. Rev.*, **21,** No. 2, 177–200 (1931). Structure of the Queen Maud Mountains, Antarctica: *Bull. Geol. Soc. Amer.*, **46,** 973–984 (1935).

[26] Stewart, Duncan, Jr., A contribution to Antarctic petrography: *Journ. Geol.*, **42,** No. 5, 550 (1934).

[27] Stewart, Duncan, Jr., The petrography of some rocks from South Victoria Land: *Proc. Am. Philosophical Soc.*, **74,** No. 4, 307–310 (1934). The petrography of some Antarctic rocks: *Am. Mineral.*, **19,** 150–160 (1934).

of the Andes of South America, be placed in a petrographic province; that the intrusives of the Edsel Ford Range, northwest Marie Byrd Land, and certain of those of South Victoria Land, high in the alkalies and possessing some petrographical characteristics of West Antarctica rocks, as zoned feldspars, be placed in a second petrographic province; and, that intrusives of the Queen Maud Mountains, South Victoria Land, and those of the Rockefeller Mountains, King Edward VII Land, high in the alkalies, but lacking in the zonary banding of the feldspars, be placed in a third petrographic province.