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The geologic setting and composition of a newly discovered manganese deposit on Hinchinbrook Island, Alaska

by

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INTRODUCTION

During the summer of 1980, a small manganese deposit was discovered on Hinchinbrook Island located in Prince William Sound approximately 40 km southwest of Cordova, Alaska (Fig. 1) A 300 m^2 rubble of Mn-rich rock fragments at an elevation of 560 m on a steep, north-facing slope appear to be derived from bedded mudstone and sandstone intercalated between overlying pillow lava and pillow breccia and underlying pillow lava. The host rock for the manganese appears to be an orange-weathering mudstone. In this report, we present a brief description of the geologic setting and composition of the deposit, the first deposit of manganese known from Hinchinbrook Island.

GEOLOGIC SETTING

Hinchinbrook Island is underlain by rocks of the late Paleocene and early Eocene (?) Orca Group (Fig. 1). The Orca Group is considered an accretionary sequence of ensimatic deep-sea fan deposits and intercalated mafic (tholeiitic) volcanic rocks that is part of a 100-km-wide belt in Prince William Sound (Winkler, 1973; Winkler and Plafker, 1981).

The Orca Group is bounded on the north by the Contact fault system (fig. 1) a major Early Tertiary plate boundary (Plafker and others, 1977). The Contact fault separates deformed flysch, greenstone, and low grade metamorphic rocks of the Late Cretaceous Valdez Group on the north from the less deformed flysch and volcanic rocks of the Orca Group on the south.

The Orca Group on Hinchinbrook Island is composed of two units: a sedimentary unit and a predominantly volcanic unit. Recent mapping indicates that the two units are in large part in fault contact (Nelson and others, 1984). Both units have been regionally metamorphased to the laumontite and prehnite-pumpellyite facies.

The sedimentary unit is chiefly feldspathic and lithofeldspathic sandstone and siltstone, with minor conglomeratic sandstone and siltstone, red-weathering shale, and hemipelagic deposits. Sandstone beds are characterized by abundant sole markings and graded bedding and by frequent convolute laminations and linguoid ripples; siltstone beds are commonly bioturbated. Some beds contain abundant carbonaceous plant remains and foraminifera of probable Paleocene age (Winkler, 1973).

The predominantly volcanic unit consists of aphyric and phyric, pillowed and massive basaltic flows and broken pillow breccia with lesser amounts of interbedded tuffaceous sandstone, purple and green weathering mudstone, and gray laminated limestone. Lateral continuity of units is on the order of 400 m and many of the resistant volcanic units can be traced laterally from massive or pillowed flows to broken pillow breccia to mudstone containing rare angular volcanic rock fragments. The limestone contains planktonic foraminifera, and rare algal, echinoid, and mollusc fragments.

The volcanic unit on Hinchinbrook Island has a probable maximum exposed thickness of about 3000 m. A 1900-m-thick measured section from within the volcanic unit has the following percentage of rock types: 22% broken pillow breccia, 20% massive basalt flows, 31% pillow basalt flows, and 27% sedimentary rocks. No dikes or feeder systems for the volcanic rocks have been recognized.

Nine microfossil collections made from throughout the measured section suggest a Cenozoic age for the volcanic sequence. Five of the samples contain planktic foraminifers that suggest water depths equal to or greater than 2000 m. Two samples contained benthic forms suggestive of shelf deposition. Five samples contain abundant pollen; one of these samples contains benthic foraminifers, and one contains planktic foraminifers.

COMPOSITION OF MANGANESE SAMPLES

The manganiferous samples collected from Hinchinbrook Island are slabs up to 30 cm in length, 17 cm in width, and 7 cm in thickness. The slabs display a crusty layering and nodular forms on flat surfaces. Two Mn-rich samples were analyzed by atomic absorption spectrophotometry, and the results are presented in Table 1. In addition to Mn and Fe, the samples contain significant amounts of Ba and Zn.

The mineralogy of the analyzed samples was determined by X-ray diffraction and petrographic study of polished thin sections. Mineral formulas are those given by Roy (1981). Manganese minerals include bementite, $Mn_7Si_6O_{15}(OH)_8$; todorokite, $(Na,Ca,K,Mn^{2+})(Mn^{4+},Mn^{2+},Mg)_6O_{12}\ 3H_2O$; birnessite, $(Ca,Na)(Mn^{2+},Mn^{4+})_7O_{14}\ 3H_2O$; ranceite, $(Ca,Mn)Mn_4O_9\ 3H_2O$, and traces of tephroite, Mn_2SiO_4, and rhodonite, $(Mn,Fe,Ca)SiO_3$. Other phases present are quartz, chalcedony, calcite, hematite, and barite.

Bementite, the principal manganese mineral, comprises approximately 45% of one analyzed sample (table 2). Bementite is pale yellow to yellowish orange and occurs in fibrous and stellate microcrystalline masses (Fig. 2). Individual crystals have a high index of refraction and near-parallel extinction. Brecciated masses of bementite are frequently cut by narrow (0.1 mm) veins of quartz and calcite. Bementite is greyish black on weathered surfaces. X-ray diffraction patterns for bementite are characterized by strong reflections at dÅ = 7.25 and dÅ = 2.50. Table 3 is a comparison of diffraction patterns of Hinchinbrook Island bementite with bementite from other localities.

Todorokite and birnessite occur as brownish black to black coatings on sample surfaces and fractures. Scanning electron photomicrographs of these surfaces reveal felty and botryoidal textures (Fig. 3). Rancieite occurs as silvery metallic coating along fractures cutting relatively pure bementite. Viewed with a binocular microscope, the rancieite has a smooth dish-like texture (Fig. 4). Scanning electron photomicrographs reveal partings that give the mineral a stacked sheet-like appearance (Fig. 5).

Quartz and calcite occur in veins and pods and commonly enclose bodies of bementite. Quartz occurs in microcrystalline and polygranular mosaics of anhedral to subhedral crystals. Pale-brown feathery crystals of chalcedony line cavities in the rock. Chalcedony also occurs in radial banded spheroids over cores of bementite.

Fe-oxide stains are present on 70% of the manganese rich samples. Locally, clusters of deep-red, microcrystalline crystals of hematite are associated with quartz and chalcedony.

CONCLUSIONS

The apparent stratiform nature, geologic setting, and composition of the Mn mineralization are supportive of a volcanogenic origin for the deposit. The deposit formed in a moderately deep-ocean environment (~2000 m) receiving turbidity current and hemipelagic sedimentation. Volcanic rocks grading laterally from massive and pillowed flows to pillow breccia may represent volcanic centers or seamounts in a marginal basin terrain.

Although the specific volcanogenic hydrothermal processes involved are uncertain, manganese deposits of this composition in similar stratigraphic settings are classified as the volcanogenic-sedimentary type (Roy, 1981). For example, Mn deposits from the Olympic Peninsula, Washington containing abundant bementite are associated with red calcareous mudstones and mafic pillow lavas (Park, 1946; Sorem and Gunn, 1967). Park (1946) concluded that Mn and Fe were leached from basalt during seafloor alteration ("spilitization") of basalt. Sorem and Gunn (1967) also suggested that the Olympic Peninsula deposits formed contemporaneously with marine volcanism and sedimentation, but details concerning the conditions of formation are uncertain.

Although the wallrock relations and the size of the Hinchinbrook Mn deposit are uncertain, the geochemical fractionation of Mn from Fe and other metals and the separation of oxide from sulfide facies in marine hydrothermal systems suggest that investigation of the deposit is warranted to determine whether related deposits of metal sulfides exist nearby.

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List of Tables

List of Illustrations

TABLE 1. Atomic absorption analyses of manganiferous samples, station number 80ANS102.

Element	Sample 1	Sample 2
Mn	29%	35%
Fe	13%	14.3%
Zn	100	3,400
Ba	6,700	3,300
Sr	290	215
Co	<30	<30
Cd	<10	<10
Pb	<50	<50
Cu	<20	<20
Ni	85	115
Cr	85	100

* Values for Mn and Fe in weight%; others in ppm,.
Analyst: Robin M. Bouse.

TABLE 2. Major mineral constituents of manganiferous sample from Hinchinbrook Island. Data is average of three 1,000 point counts.

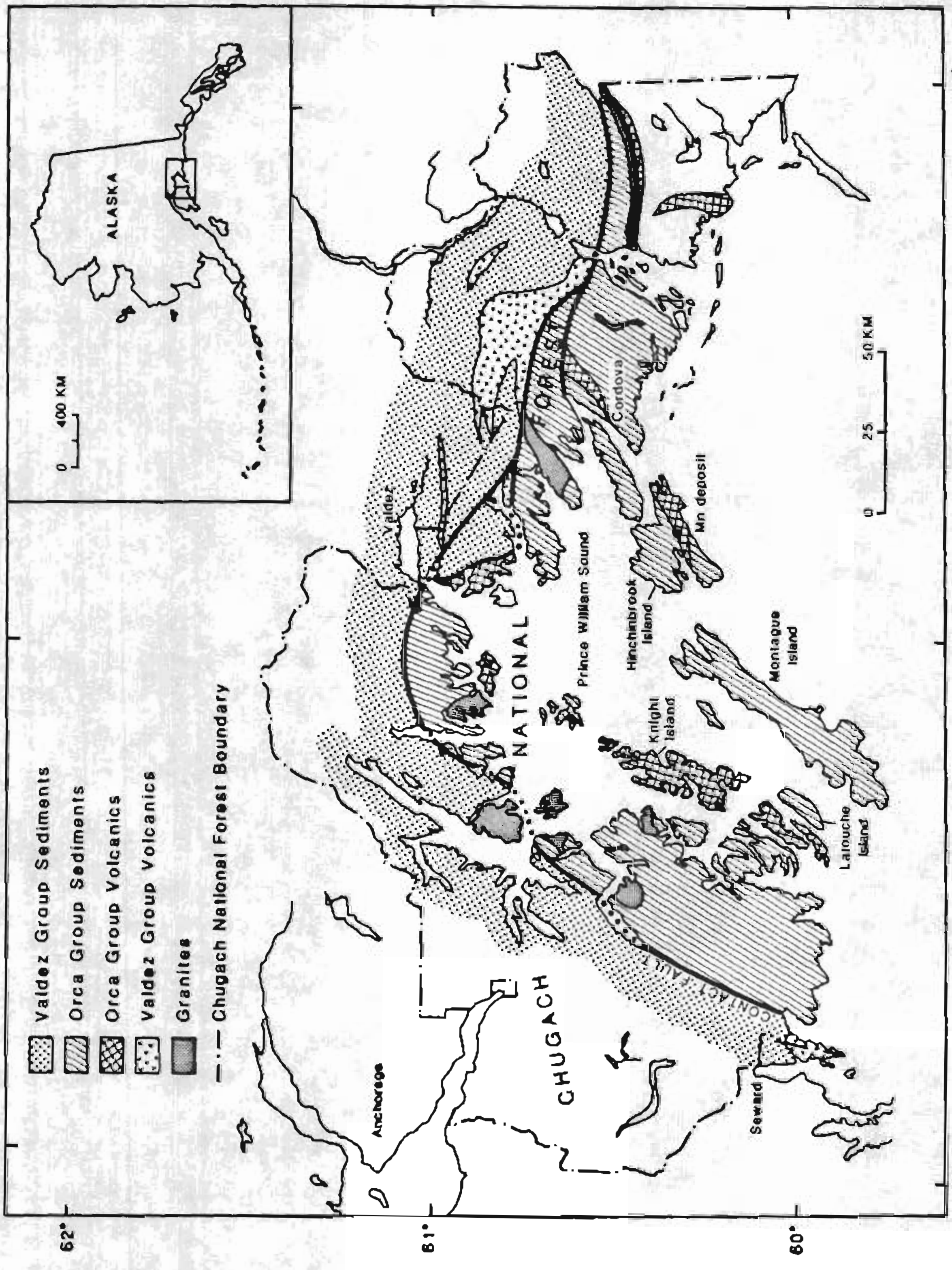
Mineral	% of specimen
Bementite	45.4%
Quartz	20.2%
Chalcedony	7.6%
Calcite	8.4%
Other (Mn, oxides)	18.4%
Barite	trace

TABLE 3. X-ray diffraction patterns for bementites.

Hinchinbrook Is.[1]		Ichinomato mine, Japan[2]		Franklin, New Jersey[3]		Crescent deposit, Olympic Peninsula,[4]	
d	I	d	I	d	I	d	I
7.25	100	7.30	100	7.25	100	7.30	100
3.61	55	3.63	60	4.60	2	3.63	50
2.80	65	2.81	70	4.40	2	2.80	40
2.51	85	2.51	90	4.06	3	2.52	60
2.37	10	2.37	10	3.97	4	2.37	15
2.09	15	2.10	40	3.66	100	2.09	20
1.80	20	1.97	10	3.58	90	1.96	5
1.73	10	1.80	5	3.43	9	1.87	tr
1.63	20	1.73	10	3.30	6	1.73	5
1.59	15	1.63	50	3.09	5	1.63	25
		1.59	30	3.01	2	1.58	15
				2.82	4	1.49	5
				2.72	4		
				2.43	14		
				2.21	2		
				2.11	7		
				2.09	6		
				2.05	2		
				1.85	2		
				1.82	4		
				1.75	2		
				1.63	2		
				1.62	2		

1. Powder X-ray diffraction analysis using CuK radiation; sample rotated at 1° 20/min.
2. Data from: Sorem and Gunn, (1967).
3. Data from: Powder Diffraction Data for Minerals, first supplement.
4. Data from: Sorem and Gunn, (1967).

Figure 1


Valdez Group Sediments
Orca Group Sediments
Orca Group Volcanics
Valdez Group Volcanics
Granites
Chugach National Forest Boundary
0 400 KM
ALASKA
Anchorage
CHUGACH
NATIONAL
FOREST
CONTACT FAULT
Seward
Valdez
Prince William Sound
Knight Island
Latouche Island
Hinchinbrook Island
Montague Island
Cordova
Mn deposit
0 25 50 KM
62°
61°
60°
150°
147°
144°

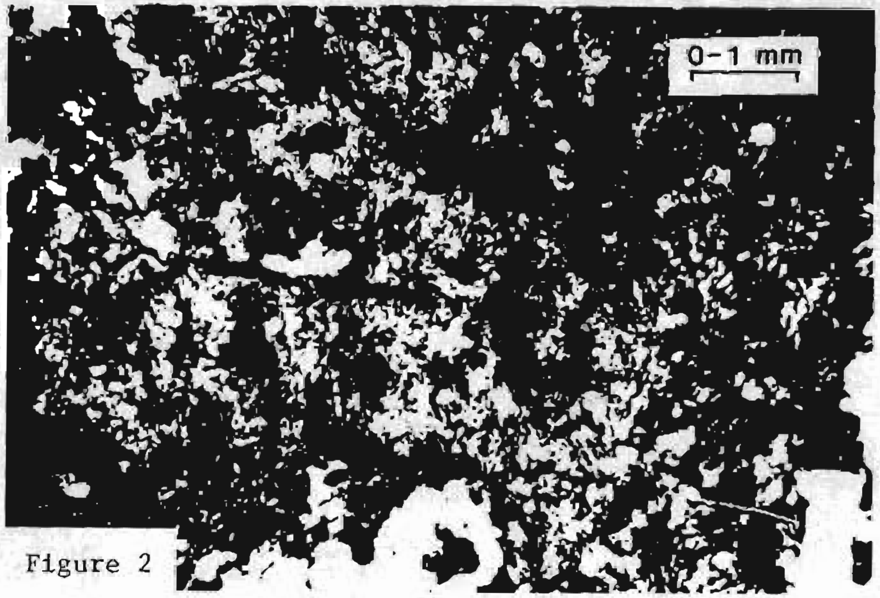


Figure 2

Figure 3

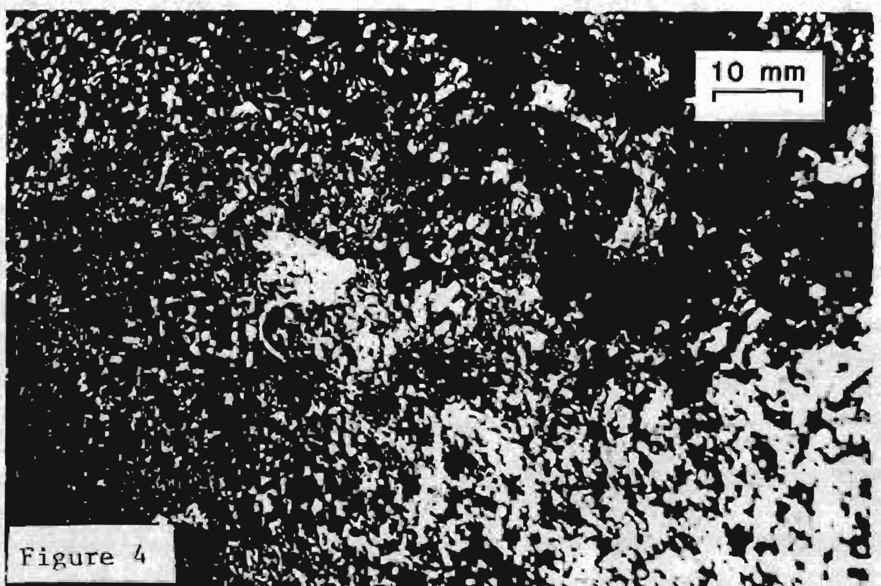


Figure 4

Figure 5