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Mineralogy of mafic and Fe–Ti oxide-rich differentiates of the Marcy anorthosite massif, Adirondacks, New York

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Abstract

Rocks enriched in mafic silicates, Fe–Ti oxides and apatite form a minor but ubiquitous facies of nearly all Proterozoic massif-type anorthosite complexes. In the Marcy massif of the Adirondack highlands, New York, the mafic rocks have two modes of occurrence: 1) as conformable segregations interpreted as cumulate layers in the border zones, and 2) as dikes throughout the massif, interpreted as having crystallized from residual liquids extracted at varying stages during differentiation. Primary mineral compositions in these rocks are commonly preserved, despite the effects of subsolidus recrystallization in the high pressure granulite facies. In the mafic rock suite, primary compositions of mafic silicates reveal an iron enrichment trend which is broadly similar to that of basic layered intrusions, but suggestive of somewhat higher crystallization temperatures. Textural relationships suggest the following crystallization sequence: plagioclase, pigeonite + augite, hemo-ilmenite + magnetite, apatite. Fe-rich olivine replaced pigeonite in the latest-stage residual liquids. The mineralogy and field relationships of these mafic rocks are consistent with their origin as differentiates from the same melts which produced the anorthosites. This conclusion agrees with recent geochemical data that suggest an independent origin for the spatially associated mangerite–charnockite suite.

Introduction

For the past several decades, the controversy over the origin of massif-type anorthosites has centered around the question of the consanguinity of anorthositic rocks and spatially associated suites of orthopyroxene-bearing granitic rocks (charnockite–mangerite series). Recent trace element geochemical studies focusing on, but not limited to, rare earth elements (REE) (Philpotts *et al.*, 1966; Green *et al.*, 1969, 1972; Seifert *et al.*, 1977; Seifert, 1978; Simmons and Hanson, 1978; Ashwal and Seifert, 1980) demonstrate that the acidic rocks do not represent differentiates from the melts which produced the anorthosites. This was recognized as early as 1939 by A. F. Buddington on the basis of field relationships (summarized by Buddington, 1969).

In addition to huge volumes of pure anorthosite, the typical massif anorthosite *suite* contains minor facies with larger proportions of mafic silicates, Fe–Ti oxides and apatite. Extreme concentrations of these minerals give rise to minor ultramafic rocks, as well as the ilmenite–magnetite ore deposits whose association with anorthosite massifs is well known (Rose, 1969). It is these mafic rocks, and not the mangerite–charnockites, which complement the anorthosites, as demonstrated by REE geochemical relationships (Ashwal and Seifert, 1980). The purpose of this paper is to describe the field relationships and mineralogical characteristics of mafic rocks associated with the Marcy anorthosite massif in the Adirondack highlands of northern New York State, and to emphasize the importance of these rocks in understanding the fractionation histories of this and other massif-type anorthosite complexes.

Field relations of mafic facies of anorthosite

In the Marcy massif, the most felsic anorthosites are found in the central regions, and more mafic varieties occur near the margins. Because of the domical form of the massif, the mafic border facies overlies the anorthositic core zone (Buddington, 1939, 1960, 1969). In some places there is a systematic increase in mafic silicates and oxide minerals from coarse, core zone anorthosite (Marcy facies) structurally upwards to finer-grained, border zone

Appendix: Sample locations

Mount Marcy quadrangle

MM-6: Oxide-rich mafic gabbro dike about 1 m thick, exposed by landslide on west side of McComb Mtn., about 400 ft. below summit.

MM-8: Pyroxenite (hypersthenite) dike about 5 cm thick, from exposures along north side of Roaring Brook at elevation of 1740 ft. (locality originally described by deWaard, 1970).

MM-13A: Oxide-rich gabbro dike about 1 m thick, oriented at N22°W; 51°W, from exposure in main trail to Mt. Marcy, about 400 ft. below summit (elevation 4900 ft.), on northeast side.

MM-14A: Oxide-rich mafic norite from exposures in main trail to Mt. Marcy from the north, about 0.75 mi. north-northeast of summit at elevation of 4420 ft. Along projected strike of MM-13A.

MM-44A: Oxide-rich wehrlite dike about 7 m thick, oriented at N65°W; 71°NE, from outcrop on south side of hill 1.2 mi. west of north end of Elk Lake, about 100 ft. north of main trail from Elk Lake to Mt. Marcy, at elevation of 2700 ft.).

MM-56: Layers of oxide-rich mafic gabbro (MM-56B) approximately 1 - 5 cm thick, oriented at N45°W; 12°NE within leucogabbroic gneiss host rock (MM-56A). From exposures at summit of Mt. Van Hoevenburg.

<u>St. Regis quadrangle</u>

SR-6: Gabbro dike about 2 m thick, oriented N0°E; 90°, from exposures on south side of 1900 ft. hill 0.5 mi. north of Gilpin Bay, Upper Saranac Lake.

SR-9: Oxide-rich gabbro dike about 1 m thick, oriented at N45°E, from outcrops on north side of road between Floodwood and Derrick, about 0125 mi. southeast of Dry Channel Pond, near 1637 ft. benchmark.

<u>Santanoni quadrangle</u>

SA-3: Layer of oxide rich pyroxenite (SA-3D) oriented at N10°E; 20°NW, gradational upwards over 4 - 5 m into oxide-rich mafic gabbro (SA-3C) and leuconorite (SA-3A). From outcrops on northwest bank of Calamity Brook, about 600 ft. north-northeast of junction with Hudson River.

SA-5: Leuconorite from outcrops on east bank of Calamity

Brook, about 300 ft. north of junction with Hudson River.

SA-14A: Oxide-rich gabbro dike about 1 m thick from large boulder in parking lot of Visitors Overlook, South Extension Pit, Tahawus ilmenite mine.

SA-15A: Oxide-rich gabbro layer (SA-15A) about 3 - 4 cm thick, oriented at N75^{O}W; 40^{O}SW, within leucogabbro host rock (SA-15B) from uotcrops on south side of 1900 ft. hill 0.25 mi. northeast of Lake Jimmy.

<u>Saranac Lake quadrangle</u>

SL-11: Oxide-rich pyroxenite layer (SL-11Y) oriented at N85^{O}W; 15^{O}NE, gradational upwards over 4 - 5 m into leuconorite (SL-11A). From roadcuts on south side of Forest Home Road, about 3 mi. west of Saranac Lake.

SL-21: Oxide-rich mafic gabbro layer (SL-21A) 4 cm thick trending N55^{O}W, within oxide-rich gabbro host rock (SL-21), from exposures on southeast side of 1700 ft. hill, 1 mi. northeast of McCauley Pond.

5654: Anorthosite, from roadcut along Rte. 3, extreme southwest corner of quadrangle. See Buddington (1939, Table 3, p. 24).

5683: Oxide-rich mafic troctolite layer or lens a few inches thick interlayered with gabbro and norite, from exposures 0.7 mi. east of north end of McCauley Pond. See Buddington (1953, pp. 61-62).