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[Manuscript received 18 August 1969]

MINERALOGICAL MAGAZINE, JUNE 1970, VOL. 37, NO. 290

Myrmekitic and non-myrmekitic plagioclase compositions in gneisses from Broken Hill, New South Wales

LITTLE correlation appears to exist between the composition of 'primary' plagioclase and the plagioclase of myrmekite in igneous rocks. This difference in composition is especially noticeable in granodiorites and adamellites. In such rocks the 'primary' plagioclase is well-zoned and can range from core labradorite through to marginal oligoclase. The plagioclase in associated myrmekite, however, is usually more sodic and is essentially fixed in composition or changes only slightly from oligoclase to marginal calcic albite (commonly with a corresponding decrease in allied quartz content). Despite recent differences in views on myrmekite genesis (e.g. Hubbard, 1969; Ransom and Phillips, 1969; Shelley, 1969) it appears that few petrologists would dispute this fairly obvious composition contrast. The situation with metamorphic rocks is, however, not as well defined and detailed comparisons between the composition of plagioclase in myrmekite and non-myrmekitic plagioclase are not easily found.

Gneisses from Broken Hill (mainly plagioclase–potash-feldspar–quartz–biotite–garnet rocks) contain plagioclase as unzoned non-myrmekitic xenoblastic crystals and as small xenoblastic myrmekitic grains associated with potash feldspar. Commonly the myrmekite appears to grow out from the larger non-myrmekitic plagioclase into the potash feldspar. In a somewhat different development in Potosi gneiss (table I, anal. 1 and 2) it forms a dense mat of lobate patches that completely surround minor amounts of crudely lenticular potash feldspar. Fine muscovite is commonly associated with such intergrowths.

TABLE I. *Chemical analyses of gneisses and plagioclases from Broken Hill. Also plagioclase compositions deduced from optical data. Rock analys. Avery and Anderson; plagioclases D. M. Ransom, by microprobe*

	1	2	3	4	5	6
SiO ₂	65.26	65.80	65.30	66.55	67.80	67.64
TiO ₂	0.75	0.79	0.91	0.72	0.67	0.72
Al ₂ O ₃	16.39	15.85	15.77	16.05	15.91	15.87
Fe ₂ O ₃	0.54	0.61	1.52	0.64	0.30	0.69
FeO	5.59	5.52	5.95	5.87	4.22	4.65
MnO	0.07	0.08	0.12	0.07	0.04	0.06
MgO	1.33	1.43	1.63	1.52	1.27	1.25
CaO	3.08	2.75	2.63	2.61	2.36	2.06
Na ₂ O	3.66	3.57	1.95	2.87	3.22	2.65
K ₂ O	3.12	3.30	3.60	2.44	4.00	4.00
H ₂ O+	0.40	0.48	0.24	0.51	0.36	0.41
H ₂ O-	0.08	0.13	0.16	0.05	0.14	0.14
P ₂ O ₅	0.27	0.24	0.17	0.30	0.18	0.13
Total	100.54	100.55	99.95	100.20	100.47	100.47
An/(Ab+An)	30.14	27.75	41.98	31.15	27.88	29.47
<i>Non-myrmekitic plagioclase</i>						
K ₂ O	0.1	0.1	0.2	0.3	0.1	0.2
Na ₂ O	7.2	7.0	7.1	7.6	8.5	8.2
CaO	7.9	7.6	7.9	6.3	5.6	6.1
Or	0.6	0.6	1.2	1.7	0.6	1.2
Ab } Mol. %	61.9	62.1	61.2	67.4	72.9	70.0
An }	37.5	37.3	37.6	30.9	26.5	28.8
An (opt.)	41-2	38-40	41-2	35	27-9	33-4
<i>Myrmekitic plagioclase</i>						
K ₂ O	0.1	0.1	0.1	0.1	0.1	0.1
Na ₂ O	7.3	7.2	7.1	7.7	9.0	8.3
CaO	7.4	7.0	7.5	6.2	4.8	6.2
Or	0.6	0.7	0.6	0.6	0.6	0.6
Ab } Mol. %	63.7	64.6	62.6	68.8	76.8	70.4
An }	35.7	34.7	36.8	30.6	22.6	29.0
An (opt.)	40.5	—	40.5	35	23-8	32

1. Potosi gneiss (0550N/0130E). Rock no. 7286 Australian National University collections.
2. Potosi gneiss (0550N/0130E). Rock no. 7288 Australian National University collections.
3. Platy gneiss phase, Footwall granitic gneiss (30850S/13500E). Rock no. 7289 Australian National University collections.
4. Augen gneiss phase, Hanging Wall granitic gneiss (12950S/0850E). Rock no. 7285 Australian National University collections.
5. Augen gneiss phase, Hanging Wall granitic gneiss (3650S/1350W). Rock no. 7287 Australian National University collections.
6. Augen gneiss phase, Hanging Wall granitic gneiss (7600S/0350W). Rock no. 7284 Australian National University collections.

Co-ordinates are those of Broken Hill South Ltd., 2000 scale geological map of the Broken Hill area. Rock names refer to rock units in the Broken Hill 'mine sequence'.

The myrmekite in some of these rocks was examined in the first place to ascertain whether a proportionality relationship exists between the composition of the plagioclase and the amount of associated quartz (Phillips and Ransom, 1968). It was later decided to extend and to refine the determinations of composition of plagioclase at both myrmekitic and non-myrmekitic sites. For this study six typical gneisses were selected and their chemical analyses and normative $An/(Ab+An)$ ratios are given in table I.

Optical measurements (based on extinction angles normal to a) indicate a similar composition for non-myrmekitic and myrmekitic plagioclase (table I). Even where accurate measurements could not be made for the myrmekite a continuity in extinction between non-myrmekitic and attached myrmekitic plagioclase suggested the same or similar composition throughout. To supplement these data, microprobe analyses were carried out on the same specimens using the A.R.L. microprobe of the Department of Geophysics and Geochemistry, Australian National University; the results are included in table I. Although differences exist between the results obtained by the two methods, each method indicates that for the same metamorphic rock the compositions of non-myrmekitic and myrmekitic plagioclase are very similar. This relationship contrasts with that suggested for igneous rocks.

One of us (Phillips, 1964) has proposed that myrmekite in some igneous rocks forms by exsolution from potash feldspar and this idea appears to be finding increasing support (e.g. Hubbard, 1967; Widenfalk, 1969). It is difficult, however, to explain the myrmekite in the metamorphic rocks noted above as the product of exsolution. The problem is that, in general, exsolution can hardly control the composition of the plagioclase in myrmekite to make it the same as non-myrmekitic plagioclase. We do not at present favour the idea that the form of the myrmekitic plagioclase is essentially relict, the composition having been modified in some later drive towards equilibrium. If such were the case the plagioclase-quartz proportionality relationship suggested by earlier work (Phillips and Ransom, 1968) would not hold. Other theories of myrmekite genesis such as replacement of potash feldspar by plagioclase or some kind of simultaneous quartz-plagioclase crystallization may explain the myrmekite noted here, especially those intergrowths found in the Potosi gneiss (where displaced potassium may be held in the associated muscovite). At present we prefer to leave the question of genesis open until a detailed study of the petrography of the gneisses can be undertaken, especially in regard to retrogressive metamorphism.

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[*Manuscript received 5 August 1969*]

MINERALOGICAL MAGAZINE, JUNE 1970, VOL. 37, NO. 290

Arsenolamprite confirmed from the Copiapó area, northern Chile

UNTIL its characterization by Johan (1959), arsenolamprite, the orthorhombic modification of native arsenic, had an unconvincing career as a mineral species. This name was first applied, by Hintze (1886), to apparently pure black arsenic from 'Copiapó, Chile', but both Jung (1926) and Paděra and Fišera (1956) found only rhombohedral arsenic in X-ray studies of specimens from this area. However, it has not been clear whether the specimens examined by these authors were similar to that described by Hintze.

In the course of an examination of hypogene mineral assemblages from the Mina Alacrán polymetallic veins in the Pampa Larga mining district (27° 36' S.; 70° 11' W.), near Copiapó, Atacama Province, Chile, the occurrence of arsenolamprite has been confirmed by X-ray and electron microprobe study. This district is the only well-known locality for native arsenic in the Copiapó area, and was very probably the source of the specimens examined by Hintze and later workers.

The Mina Alacrán veins comprise a gangue of baryte, quartz, and calcite, in association with a varied suite of hypogene ore minerals, among which stibnite, pyrite, galena, orpiment, realgar, and native arsenic predominate (Seegerstrom and Parker, 1959). In addition to these minerals, Parker, Salas, and Pérez (1963) record 'argentite', native silver, 'sulphosalts of silver', chalcopyrite, and pitchblende, while the author has identified arsenopyrite, sphalerite, greigite, high-realgar, and smithite, as well as arsenolamprite, in specimens unaffected by supergene oxidation. A more comprehensive discussion of the assemblages represented in this complex ore is in preparation. The mineralization is probably of lower Palaeocene age, by analogy with that associated with the nearby Cabeza de Vaza pluton (Sillitoe, Mortimer, and Clark, 1968).

Arsenolamprite was found to occur in appreciable amounts in two hand specimens taken from the dumps of the mine, but is generally subordinate to normal rhombohedral arsenic in the ore in sight. The striking flaky or scaly habit noted by Hintze (1886) is well shown in these samples, and the arsenolamprite does not show the