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5. MYRMEKITE FORMED BY EXSOLUTION?

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In order to remain open to other possibilities for the origin of myrmekite, I report the following two sites in this presentation in which bulbous myrmekite on the border of perthitic orthoclase is suggested by other investigators to form by exsolution.

Weinsberg (Moldanubian) Granite, Austria

At the first site, the Weinsberg (Moldanubian) granite and an older quartz-monzonite facies of the South Bohemian pluton in Austria both contain orthopyroxene and clinopyroxene and must have crystallized from magmas at high temperatures. The granite contains orthoclase megacrysts (as much as 10 to 20 cm long), which (1) are chemically zoned with Ba-rich cores (1 to 2 % mol Cs; and locally as much as 6 to 8 % Cs) and (2) are mineralogically zoned with aligned inclusions of plagioclase whose subhedral to euhedral faces are parallel to potential faces of the orthoclase (from illustrations at poster session, III Hutton Symposium, Koller and Kloetzli, 1995; personal communication, Koller, 1996). The megacrysts are perthitic and locally are bordered by small bulbous myrmekite with tiny quartz vermicules. Plagioclase lamellae are absent in the orthoclase adjacent to the myrmekite. The myrmekite is also associated with symplectic biotite which Koller and Kloetzli (1995) suggest is formed by the breakdown reaction orthopyroxene + K-feldspar + water = biotite + quartz.

Discussion

Koller (personal communication at the Hutton Symposium, 1995) suggested that the myrmekite bordering the orthoclase megacrysts was formed by exsolution. If that is true, it should have contrasting characteristics with myrmekite formed by K-metasomatism. For example, myrmekite formed by exsolution should be associated with orthoclase, whereas myrmekite formed by K-replacement would most commonly be found bordering microcline rather than orthoclase (although myrmekite borders orthoclase in a few localities, such as the Cooma granodiorite in Australia). Exsolution myrmekite would be expected to form on orthoclase with Ba-rich cores and Ba-poor rims, whereas myrmekite formed by K-replacement should be associated with K-feldspar that lacks Ba zonation (unless the original plagioclase had a Ba zonation). Exsolution myrmekite should be associated with perthitic orthoclase in which the albite lamellae have a uniform distribution and be absent adjacent to the myrmekite. Replacement myrmekite, on the other hand, should be associated with perthitic microcline in which albite lamellae could have a uniform distribution of plagioclase lamellae, but more often the distribution would be irregular, and the lamellae shape, abundance, or position would show no correlation with the position of nearby myrmekite. Finally, ghost myrmekite (intergrowths of albite and tiny quartz blebs) would be a common occurrence in microcline bordered by replacement myrmekite but would not be expected to occur in orthoclase crystallized from magma and bordered by exsolution myrmekite.

Although the myrmekite in the Moldanubian granite has many characteristics for a possible exsolution origin, Mehnert and Busch (1985) reported that late deformation and fracturing has permitted "younger infiltrations of hydrothermal (?) solutions of Ba-rich K-feldspar" in the Wehra-Wiesental granodiorite and that these same infiltrations occur in the nearby Moldanubian granite. In the Wehra-Wiesental granodiorite in which the orthoclase megacrysts have been deformed and fractured, the K-feldspar megacrysts are enriched to 1.7% BaO along the rims relative to 0.4-0.5% BaO in the cores. This suggests that late-stage K-feldspar replacements of plagioclase along the rims of the K-feldspar megacrysts in the Moldanubian granite could have occurred to produce the myrmekite and to form secondary K-feldspar enriched in K and lacking albite lamellae. This hypothesis is strongly supported by the fact that K-bearing fluids are reported by Koller and Kloetzli (1995) to have replaced orthopyroxene to form symplectic biotite adjacent to the myrmekite. *If K replaced orthopyroxene, why should it not also replace adjacent plagioclase to form the myrmekite?*

A related problem

It should be noted here that although the orthoclase megacrysts in the Moldanubian granite contain aligned plagioclase inclusions in concentric zones, there is no agreement that aligned plagioclase inclusions in orthoclase indicates that the K-feldspar necessarily has a magmatic origin. For example, Schermerhorn (1956) described granite in Portugal containing K-feldspar (microcline) with concentric shells of aligned plagioclase crystals. These plagioclase inclusions have corroded boundaries that occasionally are bordered by myrmekite. He thought that the K-feldspar formed by replacement. Moreover, K-feldspar (orthoclase) megacrysts in the border of the Papoose Flat pluton in California contain concentric shells of aligned plagioclase crystals, but these plagioclase inclusions lack myrmekite. Nevertheless, Frank Dickson (personal communication, 1995) believes that these K-feldspar crystals are formed by replacement processes because similar K-feldspar megacrysts also occur in wall rock metapelites where there is no visible connection from the megacrysts to the pluton via veins or dikes. I have found that in the center of the Papoose Flat pluton, however, myrmekite occurs adjacent to interstitial (ground mass) microcline. The transition rocks from the myrmekite- and microcline-bearing pluton core to where the orthoclase megacrysts, lacking myrmekite, appear in the pluton rim have not yet been studied. Further work needs to be done on myrmekite in relationship to K-feldspar with aligned plagioclase inclusions.

Sjelset Charnockite, Norway

The second site where myrmekite is alleged to be formed by exsolution is at the Sjelset charnockite, Norway (Kees Maijer, personal communication, international conference on Eurogranites, 1996, South Norway, Stavanger to Oslo, June 10-14, 1996). The presence of olivine and pigeonite in the Sjelset charnockite pluton in Norway indicates crystallization of this rock at high temperature from magma. K-feldspar (orthoclase inverting to microcline) in this rock is locally bordered by myrmekite (Figs. 1, 3, 3, and 4. On the basis of spot-microprobe analyses of the orthoclase and albite lamellae in the K-feldspar, Maijer suggests (personal communication, 1996) that the original K-feldspar (prior to exsolution) contained 81.0% Kfsp, 16.4 % Ab, and 2.6 % An. Rough estimate of myrmekite abundance is 0.5 to 1 %, and this myrmekite consists of about 15 % quartz and 85% plagioclase (An-20).

Fig. 1. Sjelset charnockite. Chisel (blue) is 20 cm long. Rock is dark but not as black as the image shows.

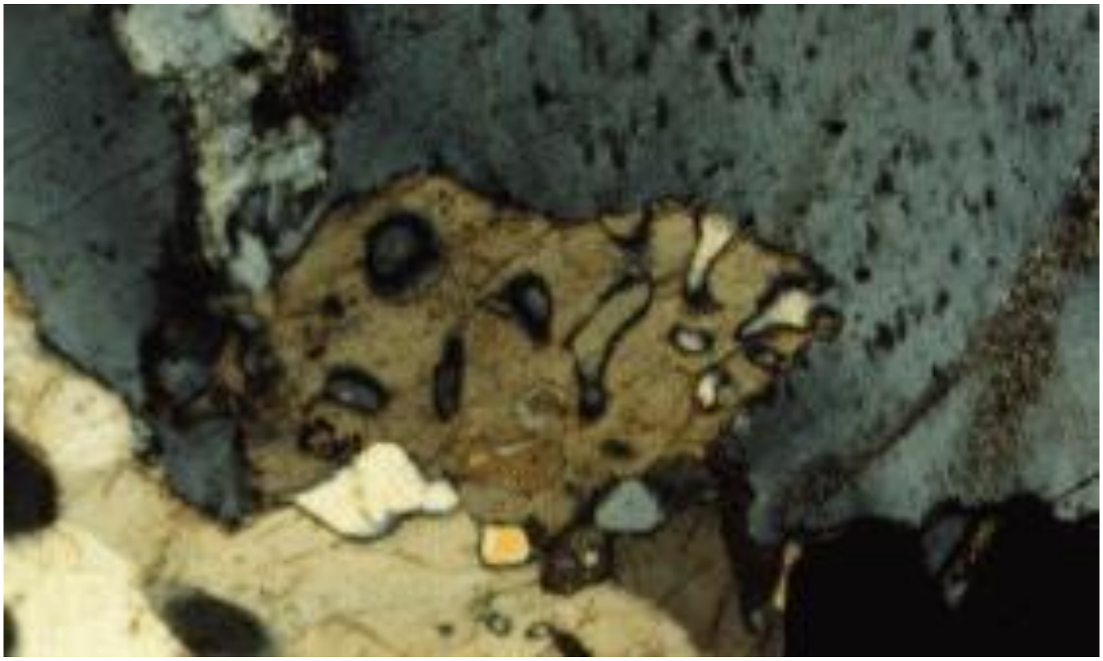

Fig. 2. Photomicrograph of myrmekite in the Sjelset charnockite. Plagioclase of myrmekite (center) has very coarse quartz vermicules (white, cream, gray). Adjacent perthitic orthoclase (gray, upper right) with plagioclase (albite) lamellae (black specks).

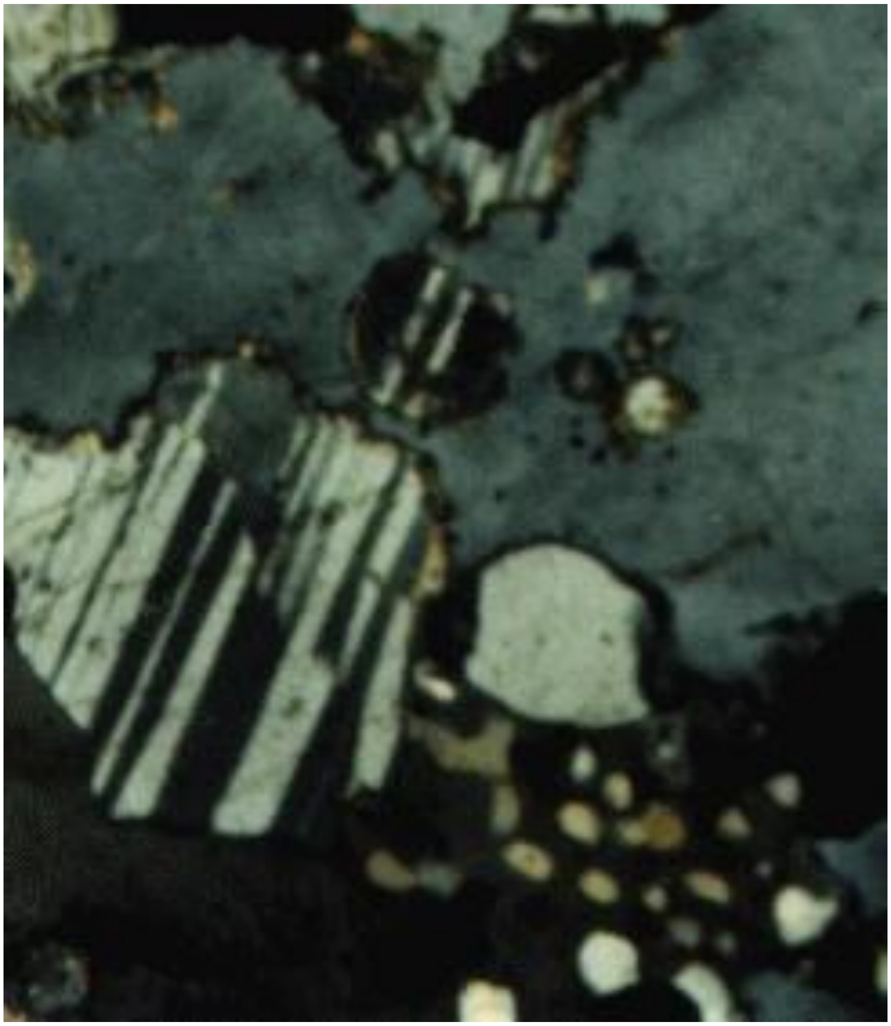

Fig. 3. Photomicrograph of Sjelset charnockite showing albite-twinned plagioclase (black and white, lower left), orthoclase (gray), and quartz (cream, white). Myrmekite with circular to oval cross-sections of coarse quartz vermicules (white to gray) is in lower right. Orthoclase (top) appears to surround a broken fragment of a plagioclase crystal because of the nearly perfect alignment of albite-twin lamellae. Fragments of the albite-twinned plagioclase (lower left) extend upward into the orthoclase.

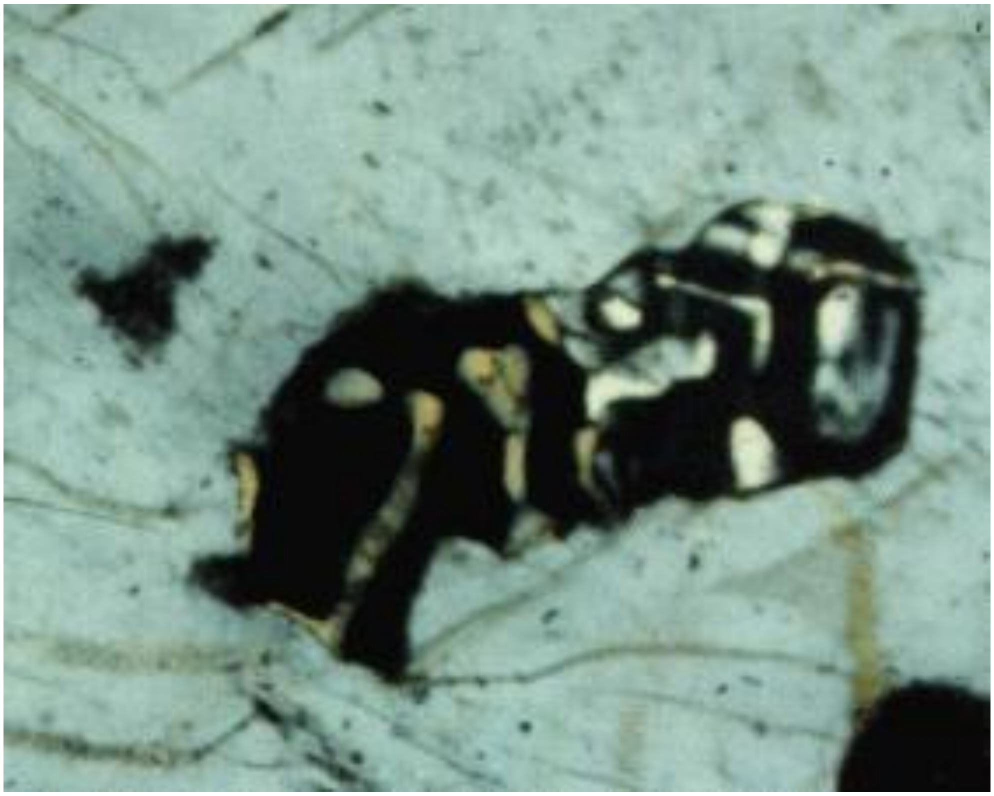

Fig. 4. Photomicrograph of myrmekite inclusion in orthoclase (light gray) in the Sjelset charnockite. Quartz vermicules (tan and white) are coarse.

Discussion

If exsolution from the orthoclase occurred to produce the myrmekite in the Sjelset charnockite, then I would expect to see a depletion of plagioclase lamellae in the orthoclase adjacent to the myrmekite. In the three thin sections that I studied, however, I saw no such depletion (Fig. 2). In addition, the presence of myrmekite inside orthoclase as an inclusion in the Sjelset charnockite makes it unlikely that it was formed by exsolution although the third dimension has to be kept in mind. Furthermore, the relative coarseness of the quartz vermicules in the myrmekite is not consistent with the sizes of quartz vermicules that are normally formed in plagioclase An-20 in myrmekite (Collins, 1988; Hunt et al., 1992). The coarseness suggests that a former plagioclase (An-60 to An-80) was replaced by the K-feldspar because of its similarity to myrmekite with about the same size of quartz vermicules where the parent plagioclase is known to be An-80; see below. A former gabbro containing plagioclase An-60 would make sense because of the presence of olivine and pyroxene in the charnockite.

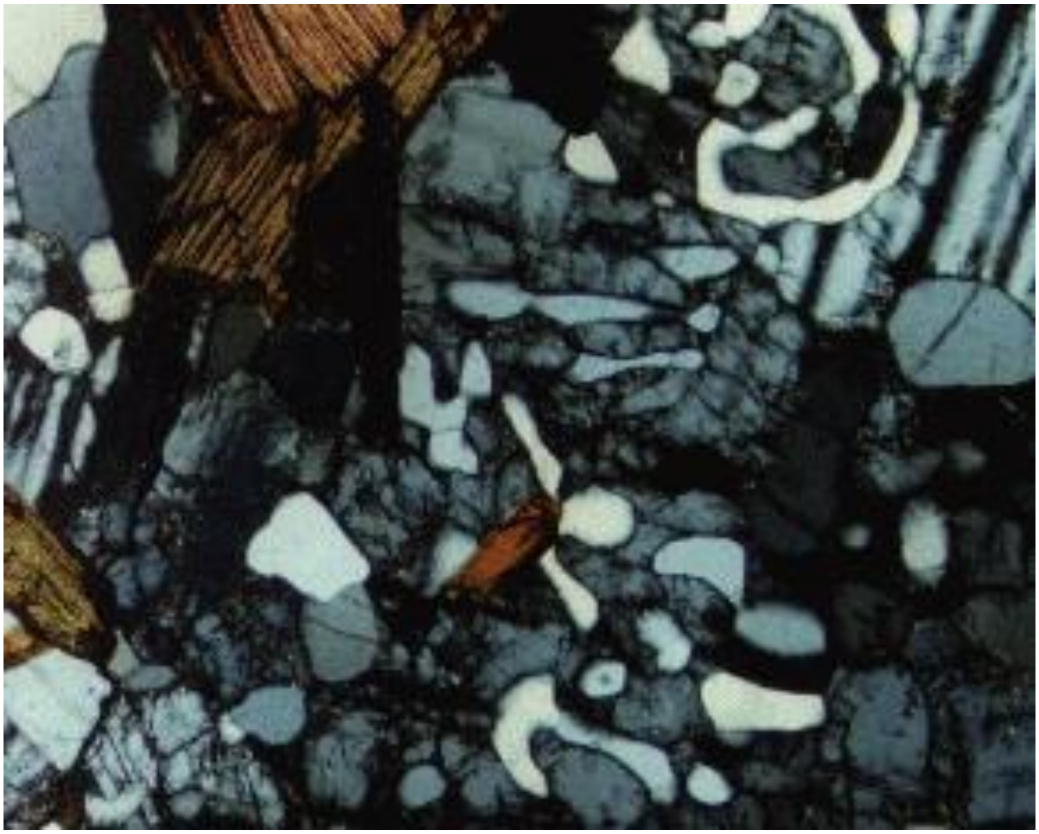

Fig. 6 from http://www.csun.edu/~vcgeo005/Nr1Myrm.pdf. This photomicrograph is from a deformed biotite-orthopyroxene gabbro layer (30-50 mm wide and 20 km long) near Split Rock Pond northeast of Dover, New Jersey.

The possibility that such a gabbro existed (where the charnockite is now) and was deformed is supported by the remnants of broken plagioclase crystals surrounded by orthoclase which are shown in Fig. 3. The deformation could cause former calcic plagioclase to be broken or fractured so that fluids could introduce K to form orthoclase, and Na displaced by this process could cause the remaining deformed plagioclase to recrystallize as more sodic plagioclase.

Kees Maijer reports, however, that a careful study of the pluton shows no traces of any gabbro, and, therefore, little support exists for the myrmekite, in the charnockite, having formed as the result of replacement of former calcic plagioclase in gabbro. Because neither of us has sufficient evidence to be convincing, the origin of the myrmekite is still in question.

References

Collins, L. G., 1988, *Hydrothermal Differentiation And Myrmekite - A Clue To Many Geological Puzzles*. Athens: Theophrastus Publications, 387 p.

Hunt, C. W., Collins, L. G., and Skobelin, E. A., 1992, *Expanding Geospheres - Energy And Mass Transfers From Earth's Interior*. Calgary: Polar Publishing Co., 421 p. Order from: http://www.polarpublishing.com

Koller, F., and Kloetzli, U. S., 1995, Remnants of lower crustal mineral assemblages in granitoid rocks: Examples from the South Bohemian pluton, Austria; in *The Origin of Granites and Related Rocks, III Hutton Symposium*, Abstracts, U.S. Geological Survey Circular 1129, p. 82-83.

Mehnert, K. R., and Busch, W., 1985, The formation of K-feldspar megacrysts in granites, migmatites and augen gneisses, Neues Jahrbuch fur Mineralogie, Abhandlungen, v. 151, p. 229-259.

Schermerhorn, L. J. G., 1956, The granites of Trancoso (Portugal): A study in microclinization, American Journal of Science, v. 254, p. 329-348.