Sericitization of plagioclase in the Rosses Granite Complex, Co. Donegal, Ireland

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Abstract

Sericitization in three separate pulses of the Rosses Granite Ring Complex, Co. Donegal, Ireland, has been investigated texturally and chemically using electron microscopy, electron microprobe and fluid inclusion thermometry. The sericitization, which is restricted to the cores of plagioclase, is associated with pores which are abundant in the cores, but absent in the margins. Alkali feldspar, although porous, is unaltered. Associated with the sericitization is alteration of the adjacent primary plagioclase within the cores of grains to a more sodic composition.

It is postulated that the sericitization resulted from the action of externally derived secondary hydrothermal fluids, which gained access to the pores in the plagioclase via now sealed microfractures, formed either by contraction during cooling of the Rosses Complex, or more likely by hydraulic fracturing by the fluids themselves. Limited fluid/rock ratios restricted the degree of sericitization within the host plagioclase, whilst an absence of alteration in alkali feldspar may have been due to the inaccessibility of pores in the alkali feldspar to the hydrothermal fluids at the time of alteration. Fluid inclusion data suggest that the fluids were of low salinity, and that the sericitization took place at an early stage in the cooling history of the Rosses Complex at temperatures between 400 and 600°C. It is further contended that greisenization in the Rosses Complex predated the sericitization and that the greisenization may have been due solely to volatile-rich late-stage magmatic fluids.

KEYWORDS: sericitization, plagioclase, Rosses Granite Complex, Ireland.

Introduction

SERICITIZATION is one of the most common types of hydrothermal alteration found in felsic rocks (Creasey, 1966; Meyer and Hemley, 1967; Rose, 1970; Lowell and Guilbert, 1970). Most studies of sericitization to date have tended to concentrate on the geochemical reactions between the early crystallized parent mineral, especially alkali feldspar, and the later hydrothermal fluids which have produced the dominant mica and subordinate related minerals (Rose, 1970; Burnham, 1962). In addition much research has been devoted to the spatial distribution of sericitic alteration in relation to igneous intrusions (Rose, 1970; Lowell and Guilbert, 1970), because of the implications for modelling economic mineral associations. In contrast to the often pervasive alteration in porphyry copper and associated rocks, sericitization is frequently only developed in plagioclase, especially in plutonic granites, and commonly alkali feldspar remains relatively unaltered to secondary minerals (Creasey, 1966).

Sericitization of plagioclase in the Rosses Granite of Co. Donegal, Ireland, is one of the most ubiquitous characteristics of this intrusive complex. The Rosses Granite Complex is a centred ring complex of Caledonian age covering an area of 70 km^2 in NW Donegal. The basic geology (Pitcher, 1953; Pitcher and Berger, 1972); mineralogy and petrology (Hall, 1966*a,b*; 1969) and geochemistry (Mercy, 1960; Hall, 1993) have been thoroughly investigated. The complex consists of four nested intrusive pulses, G1–G4, and minor porphyry dykes. At the present exposure level, the three earlier intrusions, G1–G3, are biotite granites, and the last is a muscovite granite. Sericitization of plagioclase is particularly prominently developed in the three early biotite granites.

The present paper reports an investigation of the sericitization of plagioclase in the Rosses Complex,

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specifically to study the controls on sericitization, to determine the nature of the fluids responsible for the sericitization and to speculate on the timing of the alteration event.

Petrography of the Rosses Granite Complex

Contacts between the four intrusive pulses of the Rosses Granite Complex are sharp, and the four differ in grain-size, G1 and G3 being medium-grained, G2 coarse-grained and G4 fine to medium-grained. In addition, G1 and G2 are cut by a suite of radial dykes which are not observed to cut G3 and G4 (Pitcher, 1953; Pitcher and Berger, 1972). Assemblages are almost identical for the biotite granites G1–G3, and consist of quartz, plagioclase, alkali feldspar, biotite, zircon, apatite, magnetite and secondary muscovite, chlorite and epidote. G4, on the other hand, contains quartz, plagioclase, alkali feldspar, biotite, zircon, apatite, garnet, magnetite, muscovite, chlorite and epidote.

Plagioclase and biotite were the earliest phases to crystallize in all four intrusive pulses, and are idiomorphic to subidiomorphic in habit. Quartz and alkali feldspar (microcline microperthite), the other major phases, are xenomorphic. Myrmekite is ubiquitous in G1–G3, usually replacing plagioclase at plagioclase–alkali-feldspar contacts, and appears to reflect late-stage reaction between alkali feldspar and plagioclase.

The G4 muscovite granite is texturally similar to the earlier G1–G3 pulses, except that muscovite is an abundant phase and myrmekite is absent. This unit is extensively greisenized, the main effect of which is the extensive replacement of plagioclase by coarse muscovite and alkali feldspar. Part of the G3 intrusive phase is also greisenized and is very similar to the greisenized G4 both mineralogically and texturally. The absence of myrmekite in G4 may have resulted from the greisenization.

Sericitic alteration of the plagioclase

Sericitization of plagioclase is well-developed in all the intrusive phases in the Rosses Complex, but is most characteristic of the biotite granites. Sericitization does not affect alkali feldspar, which is relatively fresh, allowing easy distinction to be made between plagioclase and alkali feldspar in thin section. The replacement of plagioclase by sericite is associated with alteration of biotite to chlorite, and both alterations are associated with development of epidote.

In the plagioclase, the sericitization is generally unevenly developed within individual crystals, and is characteristically confined to the central calcic core of the grains, or to specific zones of the crystals, and is usually surrounded by and in sharp contact with clear unaltered marginal domains, (Figs 1 and 2). Plagioclase aggregates, which have undergone synneusis during crystallization, also display sericitized cores, with their shared rim usually unaltered (Fig. 3). In numerous instances, grains of sericitized plagioclase with fresh rims are enveloped by fresh alkali feldspar (Fig. 4). This gives the impression that the sericitization may have occurred before crystallization of the fresh marginal domains. In the muscovite granite and the greisenized G3 intrusive phase, sericitization is also confined to plagioclase, but is usually much more poorly developed and more evenly distributed throughout the whole grain.

Evidence for porous pliagioclase in the Rosses Granite Complex

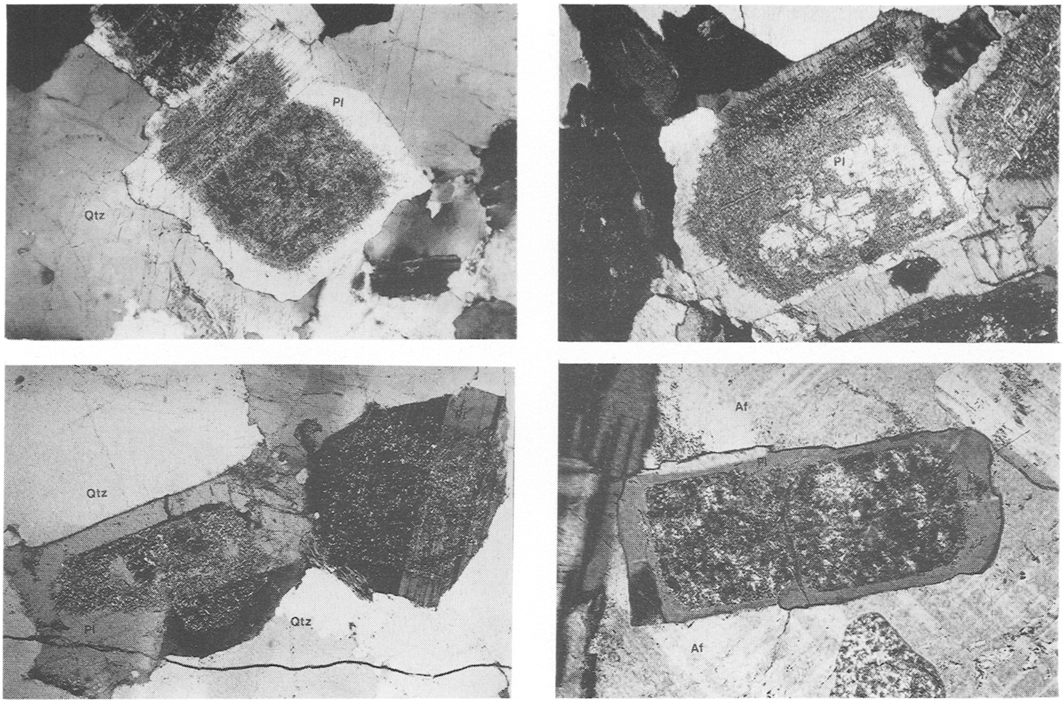
Evidence for pores in plagioclase has been observed with a standard optical microscope by Sprunt and Brace (1974), but pores in plutonic feldspars are usually far too small to be investigated by conventional microscopy (Montgomery and Brace, 1975; Worden *et al.*, 1990). No evidence for a porous nature for the plagioclase in the Rosses Granite has been recognized by conventional microscopy. However, Parsons (pers. comm., 1992) suggested that pores in plagioclase may be associated with the sericitization in the Rosses Granite.

Using high-magnification electron microscopy on both polished and unpolished surfaces, it has been possible to examine the nature of the sericitized plagioclase. It was discovered that the sericitized areas of plagioclase as observed under a conventional microscope, actually consist of tiny muscovite flakes, altered plagioclase (oligoclase) and numerous micropores (Fig. 5), which are closely associated with each other.

The micropores are generally empty and of variable shape and size. Most are highly irregular in shape (Fig. 6), and are commonly elongate, narrow and slot-like along cleavage planes (Fig. 7). The micropores are usually interconnected, and are preferentially developed in the core of the plagioclase grain, with the clear margin virtually free of micropores. Occasionally, micropores are developed along specific twin lamellae. Sericite is usually present as very tiny flakes (Fig. 6), and occasionally some flakes display elongate euhedral outlines.

Compositions of sericite and its host plagioclase

The compositions of the sericite and host plagioclase have been investigated using a Cameca Camebax electron microprobe at the Department of Geology and Geophysics, Edinburgh University. One sericite flake, and both sericitized portions and fresh rims of



FIGS. 1–4. FIG. 1. (top left) Photomicrograph of plagioclase grain showing sericitized core and fresh unaltered rim. (+) 6.3 × 10, Pl = plagioclase, Qtz = quartz. FIG. 2. (top right) Photomicrograph of plagioclase with a clearly defined sericitized zone in sharp contact with a fresh rim. The plagioclase grain is in contact with biotite at the left and with plagioclase grains. A small alkali feldspar grain is also present in the top right corner. (+) 6.3 × 10. FIG. 3. (bottom left) Photomicrograph of a plagioclase aggregate surrounded by quartz grains. The two grains of the plagioclase aggregate show sericitized cores and share a fresh rim. (+) 6.3 × 10. FIG. 4. (bottom right) A zoned plagioclase grain consisting of a sericitized core and a fresh rim, enveloped by large alkali feldspar. (+) 6.3 × 10.

plagioclase grains on polished wafers were analysed. Some results and the relative locations of analysed points in the crystals are shown in Table 1 and Fig. 9.

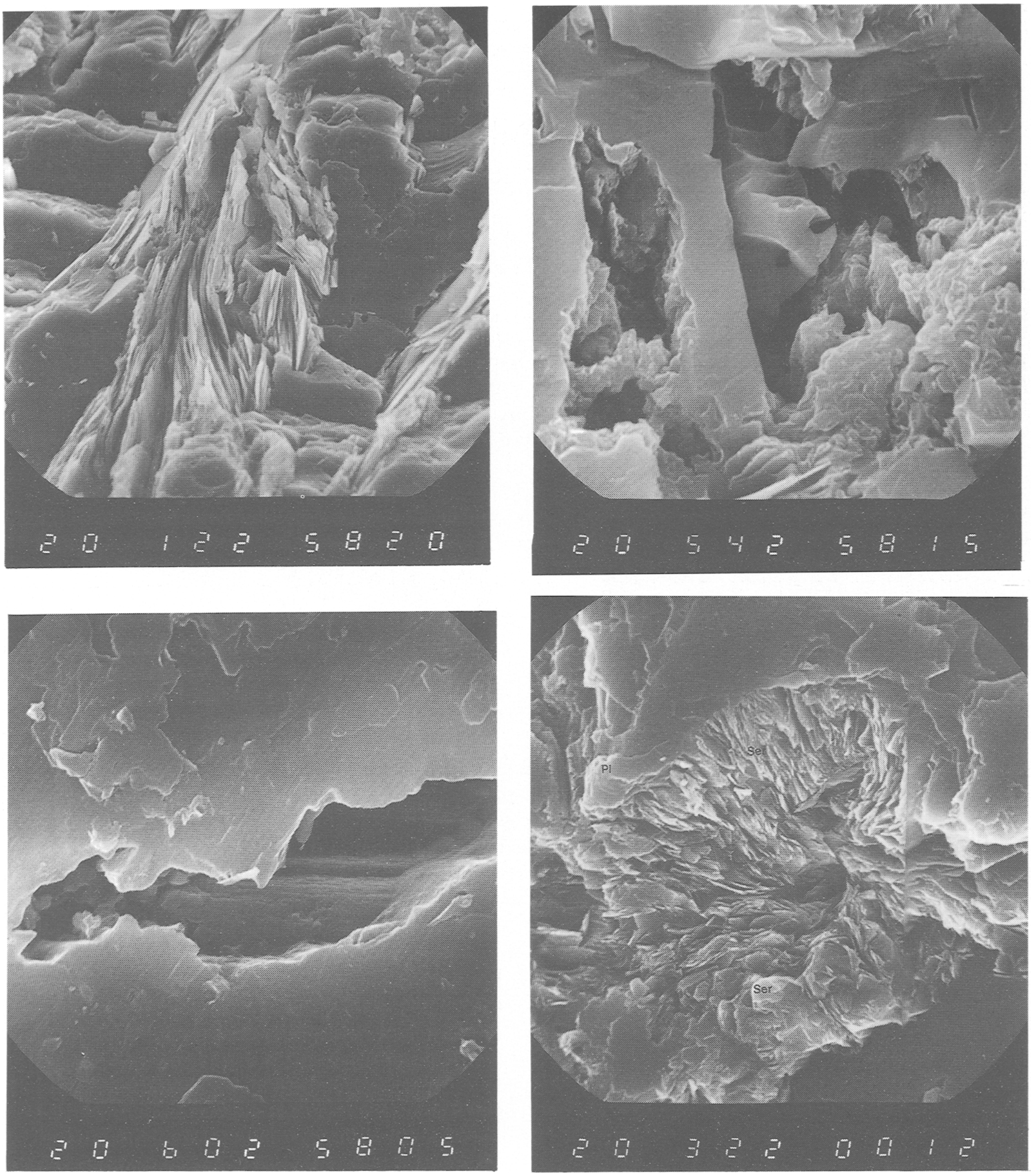
The sericite grain was determined to be a potassium muscovite of composition:

$$(K_{1.94}Na_{0.06})_{\Sigma 2}(Al_{3.15}Fe_{0.73}Mg_{0.27})_{\Sigma 4.15}(Si_{6.45}Al_{1.55})_{\Sigma 8}O_{20}(OH)_4$$

The formula was determined on an anhydrous basis, with OH contents, calculated by difference. The sericite has abnormaly high contents of Fe (total Fe calculated as Fe_2O_3 = 6.22%) and Mg (MgO = ~1.3%).

The enveloping plagioclase varies in composition from area to area within grains and from grain to grain, but it is evident that all domains of plagioclase surrounding micropores have been altered to more sodic compositions. Variations in the composition of the plagioclase are complex. The sericitized zones and all areas surrounding micropores were found to be more sodic than the original plagioclase (oligoclase), but range from An_{11}–An_{23}. The compositions of the fresh micropore-free domains of plagioclase grains change gradually from calcium rich, (An_{19-23}), near the core, to albite (An_{8-10}), at the rim. From this compositional evidence, it can be concluded that the plagioclase has also undergone compositional changes during sericitization. However, both sericite occurrence and plagioclase compositional changes are strictly controlled by the distribution of micropores in the plagioclase grains.

Compositions of the plagioclase were also determined optically by Hall (1966*b*) using a universal stage. He determined that the sericitized cores of the plagioclase had the highest An content of An_{18-19}, and that the zoned fresh rim gradually changed composition outwards from An_{19} to An_{11}. Comparing these results with the microprobe values indicated that most of the range in composition of the zoned fresh rims are consistent with the microprobe



FIGS. 5–8. FIG. 5. (top left) Scanning electron micrograph (secondary electron image) of sericite, altered plagioclase and micropores in a plagioclase grain (unpolished fragment). × 1000. FIG. 6. (top right) Scanning electron micrograph (secondary electron image) of micropores in plagioclase (unpolished fragment). ×4500. FIG. 7. (bottom left) Scanning electron micrograph (secondary electron image) of elongated clot-like micropores in plagioclase (unpolished fragment). Smaller pores at depth within the main pore also occur. ×5000. FIG. 8. (bottom right) Scanning electron micrograph (secondary electron image) of sericite flakes in a pore of a plagioclase grain.

results, but that the compositions of the sericitized cores, which represent about 2/3 of the volume of the plagioclase grains (Hall, 1966*b*) differ significantly, and compositions of the outermost rims differ slightly. Microprobe analyses of the sericitized cores of plagioclase crystals show that these

TABLE 1. Electron microprobe compositional data for sericite and sericitized plagioclase: Mus = muscovite; Pl = plagioclase; Mrgn = margin; Ctr = centre; Srd = sericitized; Cln = unaltered; Mdl = middle

	163 Mus	164 Pl-Mrgn	165 Pl-Ctr	166 Pl-Mrgn	191 Pl-SrdCtr	192 Pl-ClnCtr	193 Pl-ClnMdl	194 Pl-Mrgn
Na_2O	0.217	11.277	9.610	10.923	10.435	9.627	9.503	10.95
MgO	1.285	0.000	0.000	0.012	0.018	0.000	0.000	0.028
Al_2O_3	28.499	21.107	22.904	20.954	21.565	22.806	22.806	21.355
SiO_2	46.101	67.621	63.357	66.517	65.118	63.203	62.839	65.935
K_2O	10.865	0.070	0.229	0.082	0.153	0.095	0.253	0.119
CaO	0.028	1.665	4.083	1.736	2.731	4.242	4.217	2.114
TiO_2	0.065	0.013	0.020	0.005	0.027	0.000	0.000	0.010
Fe_2O_3	6.221	0.028	0.103	0.045	0.042	0.000	0.068	0.063
MnO	0.123	0.014	0.000	0.000	0.053	0.005	0.000	0.006
BaO	0.159	0.000	0.000	0.067	0.000	0.000	0.010	0.000
Total	93.563	101.796	100.306	100.341	100.142	99.979	99.697	100.582
Ab		0.921	0.800	0.915	0.866	0.800	0.792	0.898
Or		0.004	0.013	0.005	0.008	0.005	0.014	0.006
An		0.075	0.188	0.080	0.125	0.195	0.194	0.096

domains are usually more sodic than the inner part of the fresh margins, in sharp contradiction to Hall's (1966) assertion that the highest An contents in the plagioclase grains were in the cores.

Now rarely used, universal stage determinations of plagioclase composition are highly dependant on the optical properties of the crystal. The presence of the sericite may have affected measurements in the altered core domains. This suggests that caution must be taken in citing sericitized plagioclase compositions determined by optical methods several decades ago.

Chemistry of the alteration fluids

Fluid inclusions entrapped during sericitization have been investigated thermometrically using a calibrated Linkam TH600 programmable heating/cooling stage (Shepherd, 1981) mounted on a Leitz microscope. Frequent checks of intermediate and low-temperature calibrations were made, using Na_2CO_3 and H_2O (HPLC) as chemical standards.

Figure 10 illustrates a group of secondary fluid inclusions, within a small domain of a quartz grain

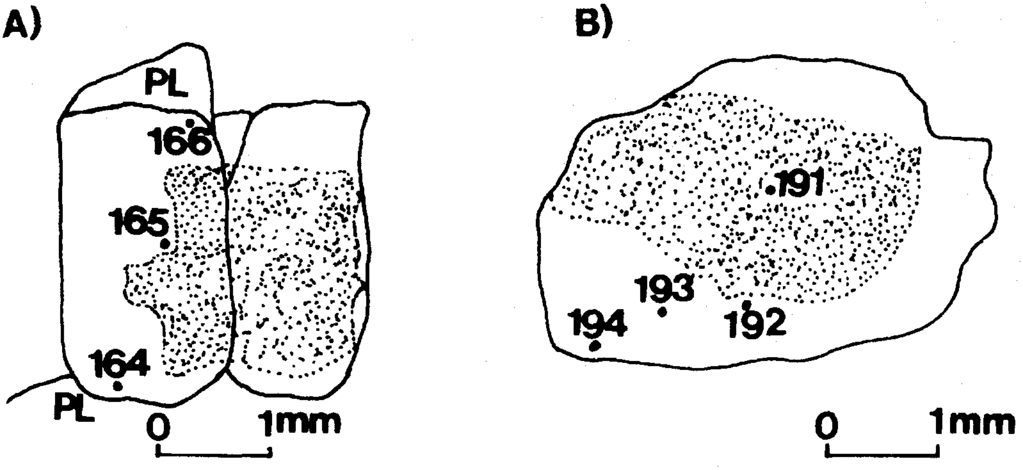


FIG 9. Electron microprobe analyses locations for two sericitized plagioclase grains. The numbers shown are the serial numbers of probe analyses.

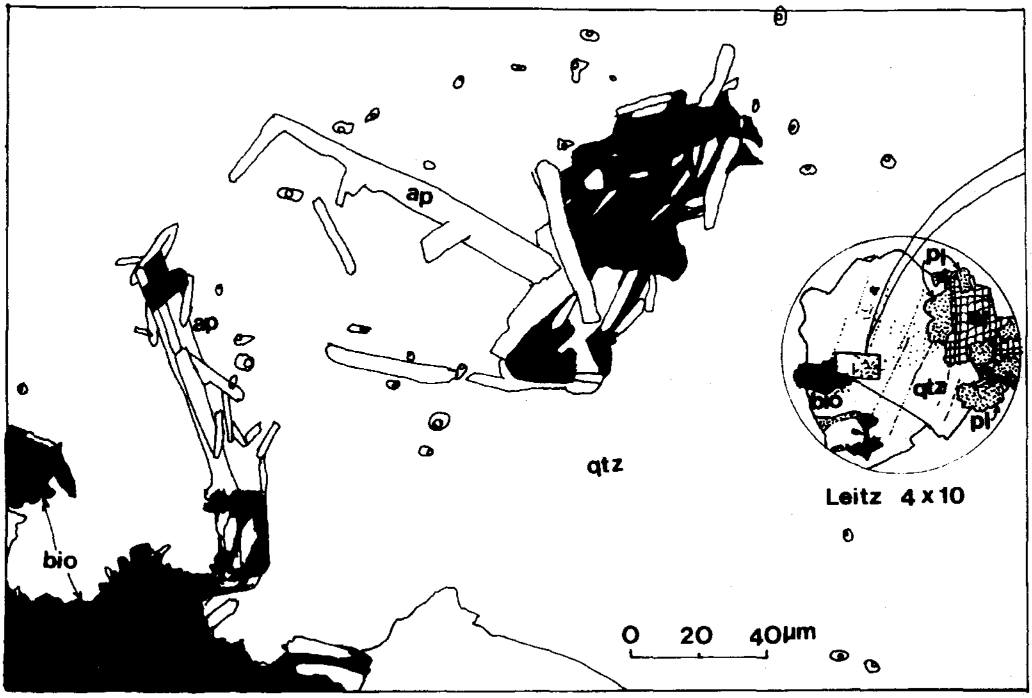


FIG. 10. Biphase fluid inclusions in quartz together with apatite crystals forming as a biproduct of the chloritization of biotite. Inset shows the relationships of the host quartz in the thin section. af = alkali feldspar, ap = apatite, bio = chloritized biotite, pl = plagioclase, qtz = quartz.

containing abundant acicular apatite crystals, and in contact with a chloritized biotite flake. These inclusion trails are interconnected with sericitized domains in adjacent plagioclase grains. This close spatial relationship with the sericitized domains in plagioclase and chloritized domains in biotite suggests that these fluid inclusions were trapped during the sericitization and chloritization event. Both these alteration types are developed only in specific domains within individual crystals, so that the fluid trapped by the quartz crystal may reflect a local focus of fluid infiltration.

These fluid inclusions are all liquid-rich L+G biphase inclusions exhibiting identical phase change properties. The fluid inclusions display freezing points of −30°C, which indicates that some other constituents, such as Fe, Mg, and/or Ca (Crawford, 1981; Kwak and Tan, 1981), are present in the solution besides KCl and NaCl (Chou, 1987). The freezing point depression of the fluid inclusions is −2.9°C, which corresponds to salinities of 4.8 wt.% NaCl equivalent, using the table of Bodnar (1993). All of the fluid inclusions homogenize to the liquid phase at 311–342°C. This phase change behaviour indicates that these fluid inclusions were trapped at a pressure higher than atmospheric, so that the temperatures of entrapment will be higher than homogenization temperatures. From the pervasive, but grain scale occurrence of the chloritization and sericitization, it can be concluded that these forms of alteration may have developed under P_{H_2O} conditions similar to those of magmatic consolidation. Entrapment pressures for primary magmatic aqueous fluid inclusions has been estimated, on the basis of fluid inclusion thermometry, CO_2-bearing fluid inclusion barometry and the minimum melting curve for granite (Tuttle and Bowen, 1958), to be of the order of 150–250 MPa. Therefore alteration of the Rosses Granite Complex is estimated to have occurred under $P-T$ conditions of 150–250 MPa and 400–600°C.

Discussion

Origin of the micropores. Micropores have been described both in plagioclase (Montgomery and Brace, 1975; Dengler, 1976; Shirey *et al.*, 1980; Kranz, 1984) and in alkali feldspar (Worden *et al.*, 1990), forming in the latter during coarsening of perthite (Worden *et al.*, 1990). Smith and Brown (1968) suggest that most pores in plagioclase are of secondary origin and result from deuteric and hydrothermal alteration (Parsons, 1978). However, Montgomery and Brace (1975) also cited the strong tendency for plagioclase to form inclusions (Roedder and Coombs, 1967; Lofgren, 1974) as evidence for a primary origin for some micropores. They suggest that micropores in the plagioclase of granites can be generated either during the early crystallization history of the rocks or as a result of annealing along cleavage planes by late-stage fluids.

Micropores in plagioclase could also be produced by dissolution in fluids along cleavages and other interfaces. Dissolution of feldspars by fluids (water or acidic solutions) is mainly controlled by surface reactions (Petrovic, 1975), with Ab-rich plagioclase more soluble than more calcic plagioclase in hydrothermal fluids (Morey, 1957; Orville, 1963; 1972). However, whereas the An-rich cores of the Rosses plagioclase are extremely porous, the Ab-rich margins are almost devoid of micropores. Furthermore, the distribution of micropores is independent of the presence of microcracks, and this would appear to exclude a dissolution origin for the micropores. It thus appears more likely that formation of most of the micropores in the Rosses plagioclase occurred during crystallization of the plagioclase, but may subsequently have been enlarged by later fluid action.

Alteration fluids and sericitization. Sericitization in G1–G3 of the Rosses Granite occurs almost exclusively in the cores of plagioclase containing micropores. The micropores in the Rosses plagioclase thus appear to have been utilised as fluid channelways for the alteration fluids. Those areas of plagioclase free of micropores were impermeable to the alteration fluids and remained fresh and unaltered. Although microcracks pervade the rocks, sericitization is not developed along cracks where they transect plagioclase grains or along grain boundaries. This suggests that the alteration fluids had access only to areas of the plagioclase with micropores and that alteration occurred earlier than the fracturing of the rocks.

Textural and compositional evidence indicate that the altered domains of plagioclase were attacked by the alteration fluids in two ways: (1) selective replacement of plagioclase by sericite; and (2) replacement of Ca^{2+} by Na^{+} in the surviving plagioclase to form slightly more sodic plagioclase.

Some areas in the alkali feldspar of the Rosses Granite are also porous, but this mineral has remained unchanged in composition. This implies that the alteration fluids were unable to gain access to the pores in the alkali feldspar, so that no alteration of the alkali feldspar took place.

If alteration of the plagioclase was controlled by surface reactions, fluid/rock ratios would determine the intensity of the alteration. Limited sericitization of the plagioclase suggests that the fluid/rock ratios were low, and the incomplete sericitization of the cores of the plagioclase and only minor compositional alteration of the remaining plagioclase in the altered areas rather than complete albitization, suggests that the salinities of the alteration fluids were also low. In addition, fluid inclusion evidence also indicates that the alteration fluids were of low salinity and were multi-component hydrothermal fluids with temperatures in the range 400–600°C.

Hall (1993) has presented data on the ammonium distribution in the rocks and minerals of the Rosses Complex. He has shown that most of the ammonium in the complex is of secondary hydrothermal origin, the proportion of secondary ammonium ranging up to over 80% of the total ammonium content in some rocks. Hall found that the ammonium content of individual samples is related to the degree of alteration of the sample, specifically the degree of sericitization of the plagioclase and chloritization of the biotite. He also found that the greisenized rocks showed no greater concentration of ammonium than other rocks in the complex, suggesting that introduction of secondary ammonium to the complex may not be associated with the greisenization.

The above evidence indicates that sericitization of the plagioclase in the Rosses Complex was brought about by hydrothermal fluids of external derivation, the sericitization process being controlled by the cores of the grains. Access of the fluids to the porous plagioclase cores was probably effected via microfractures in the plagioclase, now sealed and marked by lines of fluid inclusions. Microfracturing of plagioclase may have occurred due to contractional cooling forces or more likely by hydraulic fracturing brought about by fluid pressures due to the hydrothermal fluids themselves. Variability in the degree of sericitization throughout the Rosses Complex suggests that fluid/rock ratios may have varied geographically within the complex, or possibly even from rock to rock, with the degree of alteration developed within individual rocks and plagioclase grains being dependent on the degree of access of the fluids.

Fluid temperatures of the order of 400–600°C, determined by fluid inclusion thermometry, suggest that the sericitization must have occurred very soon after intrusion and final solidification of the granite, whilst it was still in the early stages of cooling. Access of the fluids may thus have been limited by the plasticity of the granitic rocks and minerals, and the absence of alteration of the alkali feldspar may be related to the late formation and thus possible greater ductility of the latter at the time of fluid ingress, that may have inhibited access of the alteration fluids to porous domains in the alkali feldspar.

The sericitization process appears to have resulted from reaction of the ionised hydrothermal fluids with the walls to the pores in the plagioclase cores, resulting in formation of sericitic muscovite and a more sodic plagioclase. This brought about release of Ca^{2+}, which combined with other components released during associated chloritization of biotite, to form epidote by a reaction of the form:

$$\underset{\text{Plagioclase 1}}{\left\{\begin{matrix} x\mathrm{NaAlSi_3O_8}\\ y\mathrm{CaAl_2Si_2O_8}\end{matrix}\right.} + K^+ + Na^+ + Fe^{3+} + Mg^{2+} + H_2O \rightarrow$$

$$\underset{\text{Sericite}}{(K,Na)_2(Al,Fe,Mg)_4Si_6O_{20}(OH)_4} + \underset{\text{Plagioclase 2}}{\left\{\begin{matrix} x+m\mathrm{NaAlSi_3O_8}\\ y-m\mathrm{CaAl_2Si_2O_8}\end{matrix}\right.} + 2mCa^{2+} \rightarrow \text{Epidote}$$

Other alteration effects associated with these externally derived hydrothermal fluids were late stage grain boundary replacement reactions such as myrmekitization of plagioclase. Volume changes associated with all of the alteration reactions, together with contractional cooling forces, may have subsequently led to formation of the microfractures now seen in thin section.

The greisenization. In contrast to the pervasive but restricted normal alteration effects seen in the G1–G3 phases of the Rosses Complex, the localized, but more intense, greisenization of parts of G3 and G4, where no unsericitized plagioclase survives, may be related to much higher fluid/rock ratios. In this case, however, the alteration fluids may be primary late-stage magmatic fluids with higher volatile contents due to the highly fractionated nature of the residual magma, rather than the external hydrothermal fluids responsible for the sericitization and chloritization, introduced during cooling of the complex. If this is so then it would appear that greisenization took place prior to sericitization, as has also been contended by Hall (1993). This is also consistent with Hall's observation that ammonium is not more highly concentrated in greisenized samples of the Rosses than in other phases of the complex.

Hall (1993) believes that the ammonium contents in the greisenized rocks resulted from invasion of the sericitization fluids, subsequent to greisenization. However, it is also possible that virtually all of the ammonium in these rocks is the result of the greisenization process, and that the greisenized rocks were practically unaffected by the hydrothermal fluids which either did not gain access to these rocks, or due to the lack of biotite or unaltered plagioclase in these rocks did not react with them. This absence of any alteration of the greisenized rocks by the hydrothermal fluids may be reflected in the lack of myrmekite in them.

Hall (1993) has argued that the ammonium in the greisenized rocks, which is of the order of 10 ppm, twice the normal ammonium content of granites, is mainly of hydrothermal origin, and that the greisenization process was not accompanied by ammonium enrichment. However, if the greisenizing fluids were of late-stage magmatic origin, enrichment of the greisenizing fluids in ammonium might be expected, as the NH_3^+ ion has a large ionic radius (1.50 Å; Wells, 1984) and has a tendency to substitute isomorphically for potassium in micas and alkali feldspar (Hall, 1993), and would thus become concentrated in the late-stage volatile and potassium-rich magmatic fluids. Greisenization by these late-stage primary magmatic fluids, involving replacement of plagioclase by sericitic muscovite and alkali feldspar, could lead to concentration of primary magmatic ammonium in the greisenized rocks. Partitioning of ammonium between the main rock forming minerals in granites (Honma and Itahara, 1981), indicates that muscovite and alkali feldspar both normally have ammonium contents four times greater than that of plagioclase. Thus the greisenization process could lead to concentration of ammonium in the greisenized rocks to the levels measured by Hall (1993), and no secondary introduction of ammonium by the hydrothermal fluids need have occurred.

Thus, it is argued that alteration of the Rosses Complex occurred in two main stages, an earlier very localized greisenization, brought about by late-stage, volatile-rich primary magmatic fluids, and a later more pervasive but generally less intense alteration, resulting in sericitization, chloritization, epidotization and myrmekitization brought about by secondary hydrothermal fluids of external origin that altered the whole of the complex, but may have had little effect on those rocks of the complex that had previously undergone greisenization. Both events appear to have occurred at high temperature, possibly almost immediately after final solidification of the complex, the earlier characterized by high fluid/rock ratios, and the later by low fluid/rock ratios and low-salinity fluids.

Conclusions

1. Pervasive sericitization of plagioclase in the Rosses Granite Ring Complex is restricted to the cores of the plagioclase grains, controlled by micropores confined to the cores of the plagioclase.

2. Sericitization in the Rosses Complex resulted from influx of low salinity hydrothermal fluids of external origin at temperatures between 400 and 600°C.

3. Access of the hydrothermal fluids to the porous plagioclase cores was via microfractures, which may

have resulted from hydraulic fracturing by the invading fluids. Low fluid/rock ratios limited the degree of sericitization that ensued, but variable fluid/rock ratios within the complex may be responsible for variations in the degree of alteration from rock to rock. The absence of alteration to alkali feldspar may be due to the inaccessibility of the hydrothermal fluids to porous domains in this mineral.

4. Sericitization took place by reaction of the hydrothermal fluids with the walls of the pores in the plagioclase, resulting in growth of sericitic muscovite and conversion of the remaining plagioclase in the cores to a more sodic composition. Associated alterations were chloritization of biotite, epidotization and myrmekitization of plagioclase.

5. Greisenization of parts of the G3 and G4 intrusions of the Rosses Complex predated the sericitization event and is thought to be due to fractionated volatile-rich late-stage primary magmatic fluids.

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