Textural Evolution in the Transition from Subsolidus Annealing to Melting Process, Example of the Velay Dome, French Massif Central

Karel SCHULMANN[1]*, Christophe DALLAIN*[2] *and Patrick LEDRU*[3]

[1] *Charles University, Institute of Petrology and Structural Geology, Albertov 6, Praha 2, Czech Republic*
[2] *Université Rennes, Laboratoire de Géologie, Campus de Beaulieu, 35042 Rennes, France*
[3] *Bureau de Recherches Geologiques et Minieres, DR/MGG, Boit postale 6009, 45060 Orléans, France*

Modern petrology emphasizes the use of compositional parameters to interpret the evolution of mineral assemblages in preference to detailed textural studies. However, quantitative textural analysis can provide important information regarding the thermal history of rocks. Quantitative petrographic analysis developed in the last years in Institute of Petrology and Structural Geology, Prague, is a useful, but underused tool to aid in distinguishing between subsolidus and anatetic-related textures in migmatites.

A detailed qunatitative textural analysis of an orthogneiss sequence affected by anatexis and intruded by the Velay pluton, French Massif Central, identifies the relative importance of subsolidus processes and melting in the production of migmatitic textures. This analysis focuses on assessing the relative contribution of these two processes in the development of migmatitic orthogneiss textures in the Velay Massif. The results of this study show that subsolidus processes are more important in the development of migmatitic textures in the orthogneiss than anatectic leucosome development.

Four textural stages are identified from the mylonitic non-anatectic orthogneiss, annealed, migmatitic orthogneiss to diatexite. The monomineralic K-feldspar and plagioclase-muscovite banding was transformed with increasing temperature to polymineralic plagioclase-quartz-muscovite and K-feldspar-quartz-muscovite layers by the wetting of feldspar boundaries during heterogeneous nucleation of quartz from a fluid phase at high surface energy triple points. The wetting of feldspar aggregates is due to the high mobility of quartz in aqueous fluid and its heterogeneous nucleation at high surface energy triple point channels.

A further increase in temperature led to the growth of K-feldspar probably related to production of small amounts of melt in plagioclase-rich aggregates, controlled by muscovite abundance. Solid state annealing processes in conjunction with incipient anatexis resulted in the formation of apparent granitic-like textures in plagioclase-dominated aggregates and in small amounts of granitic melts collected in lock-up shear bands. By contrast, exclusively subsolidus processes prevail in K-feldspar-dominated aggregates leading to the development of coarse-grained leucosome.

All of the above mentioned mineralogical, compositional and textural changes in plagioclase-rich aggregates seem to be consistent with dehydration melting reactions involving muscovite in the simplified systems Qtz + Ab + Ms or Ms + Qtz . This system is represented by plagioclase-rich aggregates with 20 vol.% of quartz in triple point regions and interstitial muscovite along plagioclase planar grain boundaries. A second system is represented by quartz and mica layers separating feldspar aggregates. The topology of dehydration reaction curves of muscovite + quartz + albite via:

$$\text{Ms + Qtz + Alb} >> \text{Kfs + Als +} H_2O \text{ undersaturated melt} \quad (1)$$

and that of muscovite + quartz via:

$$\text{Ms + Qtz} >> \text{Kfs + Als +} H_2O \text{ undersaturated melt} \quad (2)$$

have been studied by Thompson (1982) and by Thompson and Algor (1977) in the system $KAlO_2$ -$NaAlO_2$-Al_2O_3-SiO_2-H_2O and $KAlO_2$ - Al_2O_3-SiO_2-H_2O The experimental work of Peto (1976) has shown that reaction (1) occurs at 665 and 710°C at 5 and 10 kbar, respectively.

The composition of plagioclase An_{26} shifted reaction (1) towards slightly higher temperatures and the reaction proceeded gradually over a temperature interval, as the fugacity of water declined in the melt (Ashworth 1976). Our petrographic observations and the experimental work of Peto (1976) are consistent with *P* - *T* estimates of 5-7 kbar and 680-740°C (Montel et al. 1992) carried out for the surrounding metapelites and pelitic restites. Calculations of the volume of melt produced by muscovite dehydration melting in quartzofeldspathic rocks at 680 °C and 5kbar yield a maximum of 3–6 vol.% of granitic melt (Clemens and Vilezeuf 1987). At this stage the rheological critical melt percentage RCMP was not exceeded and the main migmatite-like fabric of orthogneiss in both plagioclase and K-feldspar aggregates is of solid state origin.

With the onset of biotite dehydration melting the plagioclase-dominated aggregates are destroyed by the melt whereas the K-feldspar aggregates may be preserved. The *P-T* estimates for this stage are approximately consistent with the experimental results of Clemens and Vielzeuf (1987) which indicated that the reaction:

$$\text{Bt +Als+Qtz+Pl ->Kfs+Grt/Crd +} H_2O \text{ undersaturated melt} \quad (3)$$

occurs at 4–5 kbar and 750–780 °C. Taking into account the maximum temperature for the biotite-dehydration melting interval at around 850 °C almost 10 to 20 wt.% of melt can originate in quartzofeldspathic rocks (Clemens and Vielzeuf 1987, Thompson 1982). At this point the RCMP may be exceeded and the plagioclase-dominated aggregates may get entirely dissolved.

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