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Microstructure and compositional change across selvedges in migmatite

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Although partial melting and melt segregation processes that occur in migmatites are relatively well understood, the chemical exchanges that occur between different parts of migmatites are not. We sampled the biotite selvedges formed between semipelitic diatexite migmatites and mafic schollen from Lac Kénogami in the central part of the Quebec Grenville Province, and investigated their field, microstructural and geochemical characteristics.

The selvedges formed between mafic schollen and melt-rich diatexite, two very different bulk compositions, and are remarkably uniform in width ($\sim$1cm) regardless the size or the shape of the mafic schollen they surround. In some places, magmatic erosion by flow of the enclosing diatexite thinned the selvedges and created biotite schlieren. Locally selvedges are slightly wider at positions considered to be pressure shadows around the schollen.

Mineral assemblages of the mafic scholle, biotite selvedge and semipelitic diatexite migmatite are: plagioclase + orthopyroxene + ilmenite, biotite + plagioclase + orthopyroxene + quartz + ilmenite $\pm$ garnet, and plagioclase + biotite + quartz $\pm$ garnet $\pm$ cordierite respectively. Mineral equilibria modeling using THERMOCALC suggests the partial melting occurred in mid-crust in the temperature range of 820˚C-850˚C and pressure of $\sim$ 5kbars.

Bulk composition profiles obtained from micro-XRF analyses scans and LA-ICP-MS traverses indicate the diffusion distance is about 3cm for all major elements and some trace elements, although each has its own pattern which correlates with the position of the mineral host. The change in plagioclase composition across selvedges and adjacent rocks by EPMA shows relatively uniform, highly calcic plagioclase (An80-90) in the mafic schollen which changes rapidly to An60-50 just before the biotite selvedge starts, the An content then declines becoming relatively constant at An35 into the surrounding diatexite. The shape of these profiles is comparable to theoretical diffusion profiles. The Mg-number ([MgO]/[MgO+FeO]) of pyroxene in two profiles across selvedges shows a decrease continuously from the mafic schollen into the selvedge.
The nearly constant width of the selvedge and the continuous change of anorthite content in plagioclase and Mg-number of orthopyroxene across the biotite selvedge suggests elements diffused across the contacts between mafic schollen and host diatexite driven by a chemical potential difference. The direction of element diffusion appears to be Mg, Fe, Ca, Sc, V, Cr, Co and Ni towards the diatexite migmatites, and Si, Al, Sr and Ba towards the mafic schollen.

Modelling selvedges as diffusion profiles shows that they formed rapidly. The eroded selvedges can be identified by their truncated profiles, and those eroded earliest began to re-establish a smooth compositional profile.