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Dirty or Tidy ? Contrasting peraluminous granites in a collapsing Orogen: Examples from the French Massif Central

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Post collisional collapse commonly enhances crustal melting. Such melting typically produces peraluminous granitic magmas. In the French Massif Central, a mid-crustal segment of the western Variscan belt, two large granitic bodies were produced during the collapse of the Variscan Belt. The St Sylvestre Leucogranitic Complex (SSyL) in the western part of the Massif Central and the Velay Migmatitic Complex (VMC) in the Eastern part. Although these two complexes are formed in similar geodynamic context they present meaningful petrological and geochemical differences.

The VMC (∼305 Ma) is clearly intrusive in migmatitic terranes. The migmatitic host recorded two successive melting events M3 (720 °C and 5kb) dated between 335 and 315 Ma and M4 (850°C and 4 kb) dated at 305 Ma. The compositions of the VMC are strictly H_2O-undersaturated and ranges from leucogranitic to granodioritic. Three main successive granite types have been distinguished (1) A heterogeneous banded biotite granite, (2) A main biotite–cordierite granite, where cordierite can be prismatic, as cockade or pseudomorphic (3) a late magmatic with large K-feldspar phenocryst and prismatic cordierite. The compositions of the VMC granites are quite similar to typical Australian S-type granites in the sense that they also show a positive correlation between ferromagnesian abundance and aluminosity.

The SSyL (∼320 Ma) is intrusive in upper greenschist facies to upper amphibolite migmatitic metasediment and orthogneiss (∼3kb). The compositional variety observed in the SSyL suggests a continuous trend from a moderately mafic, peraluminous magma (cd- and sill- granite) to a H_2O saturated granite ("two-mica" granite) facies and finally to an extremely felsic, H_2O-saturated magma. Three granitic units have been recognized in the SSyL: (1) the western "Brame Unit" composed of the less evolved cd- and sill- granite facies (2) the central "St Sylvestre Unit", composed mainly by U-rich two-mica granite, intruded by two synchronously emplaced fine grained granites to its western margin: "Fanay" (biotite dominant) and "Sagne" (Li-muscovite only) (3) the eastern "St Goussaud Unit" mostly composed of a muscovite-dominant leucogranite surrounded by Sn-W mineralization. The compositions in the SSyL have a weak ferromagnesian character, negatively correlated with aluminosity and are quite similar in composition to High Himalayan syn-collisionnal peraluminous granite (e.g. Manaslu)

Compositional trend of the VMC granite can be easily mimicked by the addition of peritectic material (i.e. produced during incongruent biotite melting) to experimental melts produced through the melting of metasediments (Dirty). Compositions of the SSyL are similar to experimental melt only (Tidy). Such differences in composition could be the results of different processes: 1) Different melting reactions as a consequence of different conditions of melting (e.g. different source composition, temperature). 2) The peritectic phases remained "trapped" in the source during melt extraction due to the structuration of the source or a lower melt viscosity (e.g. higher F, Li, H_2O contents).

Interestingly, while within dirty granites, peritectic phase entrainment controls compositional variability, Tidy granites display original melt compositional variability as well as the potential effects of late magmatic processes.