Geophysical Research Abstracts, Vol. 7, 02576, 2005
SRef-ID: 1607-7962/gra/EGU05-A-02576

Migmatite formation: self-heating vs. basal heat flow

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In many collisional orogens, large granitic batholiths have originated by in situ melting of underthrust fertile layers. This is e.g. the case in the Variscan Chain of Central Spain, where the Ávila batholith has emerged from anatexis of a metapelitic sedimentary layer at a depth of about 20 km, some 30 Ma after the main phase of Variscan collision. Strong discussion is going on whether elevated heat production of the sediments may be responsible for heating of these rocks.

We have used two dimensional tectono-thermal modelling to quantify the thermal evolution in collisional areas, especially when the lack of evidence for mantle derived melt influx makes it difficult to explain the formation of batholiths. We generated the subduction of a sedimentary layer of variable thickness (7-10km) down to the inferred depth of 20 km. We also varied the heat production values (radiogenic heat) in these anomalous sediments, between 2 (standard value) and 6 μWm^{-3}, and the basal (mantle) heat flow values, between 25 and 60 mWm^{-2}. The calculations show that for reasonable heat production values of 3-4 μW/m^3, the heat flow entering the crust from below must have been in the order of 50-55 mW/m^2. To obtain migmatites and granites using a lower published basal heat flow values (30-40 mW/m^2) it is necessary to invoke particular petrological and geochemical characteristic of these rocks. Previous authors indicate a strong control of granite generation by the composition of the migmatites (cordierite bearing). Also the migmatization released fluids in large quantities that spread along subhorizontal shear zones during the following crustal collapse and helped to produce the large anatectic bodies that were emplaced at higher levels. To conclude, in this area of the Iberian Massif, the radiogenic heat by itself cannot be the principal source of high- temperature metamorphism and granite generation.