EXPERIMENTAL CONSTRAINTS ON GRANITE MAGMAS PRODUCTION FROM ARCHEAN TO PRESENT DAY

Bruno Scaillet[1]

[1] INSTITUT DES SCIENCES DE LA TERRE D'ORLÉANS. CNRS/INSU-UNIVERSITÉ D'ORLÉANS-UNIVERSITÉ FRANÇOIS RABELAIS DE TOURS

RESUMO: Granites sensu lato (>60 wt SiO2) are the one of the main rock-forming bodies of the continental crust. Their production en masse is widely believed to be linked to the onset of plate tectonics, in which subduction of oceanic crust allows volatilisation and partial melting reactions to take place on a global scale. Water, and the many elements it carries, in particular alkalies, are indeed key ingredients needed to produce granites in any reasonnable proportions from mafic parental material. Although thermodynamic calculations have raised the possibility of producing andesite magmas from very low degree partial melting of dry mantle, available experimental data do not support such a mechanism, unless the mantle has been previously altered by some sort of, presumably subduction-related, metasomatism. The current consensus is that the vast majority of granitoids, and therefore the continental crust, is produced by partial melting/fractionnal crystallisation of basalt in a subduction zone context. Basalt floods related to hot spot activity may on occasion yield significant amounts of felsic magmas whose origin still remains disputed. Partial melting of metasediments, that is the reprocessing of erosional products of previously exposed old crust, is a mechanism also known to yield granites on a regional scale. Within this context, experiments carried out over the last 40 years have been aimed at quantitatively evaluating the P-T-fluid conditions of silicic melt production. The propensity of basalt to yield felsic magmas upon melting or crystallisation is largely controlled by the availability of volatiles, in addition to the prevailing P-T regime. Dry conditions may give rise to undersaturated, rather than quartz-saturated, felsic liquids if the the parental basalt is transitionnal, or to Fe-rich felsic rocks if the starting basalt is tholeiitic. Such conditions appears, however, unfavourable to voluminous production of evolved magmas, since they require extreme temperatures, unlikely to be reached in most geodynamic settings, except perhaps during the Hadean or early Archean. Dehydration melting involves volatiles only bound into minerals. Liquids so produced encompass a large chemical range, broadly matching the geochemical diversity of terrestrial evolved magmas, being generally metaluminous to peraluminous. Fluid present melting involves the presence of excess volatiles and is definitively the most efficient way of producing large volumes of evolved magmas. In such a scenario, low pressure melting (<20 kb) generates Al_2O_3-rich magmas owing to the instablity of plagioclase under hydrous conditions, while higher pressure is capable of producing peralkaline trondhjemites, as a result of profuse garnet crystallisation, which largely counteracts the lack of plagioclase. Pressure exerts a major role on garnet stability and abundance : garnet controls HREE abundances, and thus the more or less fractionated character of REE patterns. Strongly fractionated REE patterns of TTG and adakites (or slab melts) hint at a role of garnet in the source or during high pressure fractionation. Temperatures of slab melts do not appear to have been significatively different between modern and archean periods, but pressures may have been lower in the Archean. Recent findings show that the shift from sodium-rich to potassium-rich felsic rocks throughout geological ages may be in part related to the role of sulphur on phengite stability. Archean granitoids may come primarily from partial melting of subducted crust, with little or no interaction with mantle material, but there are notable exceptions (sanukitoids). Phanerozoic granitoids are in large part sourced into the mantle wedge, with a significant contribution from subducted slab. In all cases, granite production on Earth seems to have been always linked to water availability.