

Late-Variscan fayalite-bearing granites in Sardinia: The lower crust connection

L. CASINI¹*, A. PUCCINI¹, S. CUCCURU¹, G. OGGIANO¹
AND G. SECCHI¹

¹ University of Sassari, Department of Science of Nature and
Environmental Resources, Via Piandanna, 4 - 07100
Sassari, Italy

The Variscan [340 – 260 Ma, 1] Corsica-Sardinia Batholith (C-SB) emplaced discordantly across the orogenic structure, from the roots zone to the Gondwana foreland. Despite the scarcity (< 5%) of mafic rocks, most pre-300 Ma plutons are peraluminous biotite granites derived from dehydration melting of pre-Variscan granitoids and subordinate metasediments [2]. Lower crustal granulites observed in the deeply exhumed section of the chain [3] are thought to have developed in consequence of extensive melt extraction. The post-300 Ma granites in south Sardinia [4], instead, display the following crustal characters: ϵNd from -6 to -12, δO^{18} between 7 and 12‰, and Sr_i (₂₉₀) between 0.703 and 0.715. The rare but systematic occurrence of fayalite or pyroxene as Fe-buffering phase indicates that these A-type melts derived by partial melting of anhydrous, poorly evolved crustal material under high-T (> 900°C), low $f\text{H}_2\text{O}$ and $f\text{O}^2$ conditions [5].

Nd_{DM} model ages of post-300 Ma granites in south Sardinia are in the range 1600 - 1700 Ma, about 1 Ga older than those calculated in Corsica [6]. This implies a older lithosphere, probably accreted at the northern margin of Gondwana (S Sardinia) in early Paleozoic. The observation that this part of the chain never reached a significant crustal thickness during the Variscan event (i.e., > 40 km) support the hypothesis that granulites formed before the Carboniferous.

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A new hypothesis for the origin of HIMU and FOZO mantle end-members

PATERO R. CASTILLO

Scripps Institution of Oceanography, Univ. of California, San
Diego, La Jolla, CA 92093-0212 USA
(pcastillo@ucsd.edu)

It is widely accepted that the bulk of intraplate magmas, best represented by ocean island basalts (OIB), originate from crustal materials that had previously been subducted into the mantle. It has also been proposed that after ~b.y. of residence, such subducted materials form a number of mantle source reservoirs, represented by end-members with extreme Sr-Nd-Pb isotopic compositions^[1]. The first subducted material to be recognized was mid-ocean ridge basalt (MORB)^[2], and this was later fine-tuned as having a long time integrated (~b.y.) high U/Pb ratio (HIMU) and producing OIB with the most radiogenic Pb isotopic ratios ($^{206}\text{Pb}/^{204}\text{Pb} > \sim 19.0$)^[1,3]. However, it is becoming more evident that the compositional connection between subducted MORB and HIMU basalts is problematic^[1,4]. As an alternative hypothesis, I propose that recycled Archaean calcium carbonate (CaCO_3) is the main source of the distinct Pb-Sr isotopic and major-trace element compositions of the “classical” HIMU and Proterozoic and younger carbonate for the “younger” HIMU or FOZO end-member. This hypothesis is consistent with some of the available observations, experimental results and inferences from these data. For example, the $^{87}\text{Sr}/^{86}\text{Sr}$ and K contents of carbonates are low in the Archaean, but started to increase in the Proterozoic^[5]. CaCO_3 subduction into the deep silicate Earth may also provide important clues to the seismic velocity structure and convection in the mantle. However, the carbonate recycling hypothesis is based primarily on qualitative data and the few existing analyses of Archaean carbonates, which are expected to have very high U/Pb if precipitated out of seawater in equilibrium, do not have original Archaean seawater U/Pb ratios^[6]. Future quantitative testing of the hypothesis can be done when analytical data for unmodified Precambrian carbonates become available.

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