

Identifying Cadomian events through SHRIMP geochronology: Ediacaran magmatism in the Peloritani Mountains (S Italy)

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Augen gneisses of debated origin and unknown protolith age form much of the Hercynian basement of the Peloritani Mountains of Sicily (Calabria-Peloritani Orogen). Petrogenetic studies based on field, petrographic and geochemical features have yielded inconclusive results. The augen gneiss protoliths have variously been interpreted as ignimbrites, Ordovician granitoids, or mixed felsic volcanoclastic-sands. Three augen gneisses from different sectors of the Peloritani Mountains have been studied by SHRIMP zircon U-Pb to assess their ages and geological significance. On the basis of zircon morphology, internal structure and composition, we now consider that the augen gneiss protoliths were granitoids. The zircon consists mostly of igneous crystals or overgrowths with oscillatory zoning, and some texturally distinct cores. Igneous zircon overgrowths from the three samples gave latest Proterozoic ages of ~565, ~545 and ~545 Ma respectively. These rocks are much older than expected. The augen gneiss protoliths were produced in the latest stages of the Cadomian orogeny leading to the final amalgamation of Gondwana. Late-Archean and Paleo- to Neoproterozoic zircon cores, mostly ~2.5, ~1.0 and <0.8 Ga, were present in the two younger samples, whereas only cores younger than 0.6 Ga occurred in the older sample. The presence of large amounts of inherited zircon cores with a wide range of ages indicates a dominantly metasedimentary magma source for the two younger granitoids, and a different source for the older one. Most of the younger zircon cores (<0.6 Ga) in all samples cannot be interpreted as detrital inherited zircon given that their ages are similar to those of the melt-precipitated rims. They are better explained as zircon crystallized under anatexis conditions and/or during magma evolution. The patterns of inherited core ages, and especially the occurrence of Grenvillian ages, suggest that, unlike suggested for similar augen gneiss cropping out in Calabria, the sediments in the sources of the Peloritani augen gneisses did not have a West-African provenance.

Sourcing hydrocarbons in CO₂-rich hydrothermal systems

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Methane (CH₄) emanating from a continental volcanic-hydrothermal system in Nisyros, Greece, is processed through the abiogenic reduction of mantle- and marine limestone-derived CO₂ [1]. Evidence for the occurrence of abiogenic hydrothermal reduction of CO₂ is from the chemical and carbon isotopic equilibrium patterns. We have further characterized this abiogenic methane (C1) source for the concentrations of ethane (C2) and propane (C3), as well as for the hydrogen isotopic composition of CH₄, H₂O, H₂ and H₂S. C1/C2+ ratios are significantly higher than those typically observed for purely thermogenic sources. Hydrocarbon distribution ratios for other continental-hydrothermal sources rich in CO₂ are comparable to those of the Nisyros fumaroles implying that abiogenic methane might be significantly more widespread than previously assumed [2]. Relative concentrations of hydrocarbons in continental-hydrothermal discharges are even indistinguishable from those measured in ultramafic hydrothermal emissions. The fact that redox conditions do not seem to exert any control on the relative concentrations of hydrocarbons in hydrothermal emissions in general, implies that the same two sources account for hydrocarbon production in continental and ultramafic environments. One source generates methane exclusively through the selective abiogenic reduction of CO₂ (Sabatier-reaction). The other source produces minor amounts of methane, ethane and propane by a random process and represents either the thermal cracking of organic matter or the polymerization starting from methane.

Hydrogen isotope partitioning between H₂O, H₂S, H₂ and CH₄ in Nisyros fumaroles reveals that isotopic exchange rates are highest for H₂O-H₂S followed by H₂O-H₂. In contrast to H₂ and H₂S, the hydrogen isotopic composition of methane exhibits almost no local variations. This is in agreement with its predominantly abiogenic hydrothermal origin and with the low temperature sensitivity of the hydrogen isotope fractionation factor between water vapor and methane.

[1] Fiebig *et al.* (2007) *Geochim. Cosmochim. Acta* **71**, 3028-3039. [2] Fiebig *et al.* (2009) *Geology*, in press.