

Protracted history of continental subduction at the southern edge of the Maya Block, central Guatemala: Petrological and geochronological evidences

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The Rabinal Granite Suite is an anatectic S-type composite pluton which fringes the southernmost North America Plate margin in Central Guatemala. It is a Kfs-Pl-Ms-Qtz granite-granodiorite, showing increasing deformation along its southern margin where it is crosscut by the dextral, Late Cretaceous, top-to-NE Baja Verapaz Shear Zone. Previously considered as Devonian-Mississippian in age, it has been recently dated at 562-453 Ma. LA-ICPMS U-Pb and Ar-Ar geochronology, combined with microprobe mineral chemistry, allow precisising its P-T-time history. U-Pb zircon ages indicate a crystallization age of 471 \pm 3/-5 Ma (Middle Ordovician), as well as abundant cores inherited from the metapelitic source with main density peak distributions at 700, 806, 900, 996, 1376 Ma. Laser total fusion Ar-Ar analyses of magmatic muscovite (Si= 6.2-6.4 atoms per 20 O and 4 OH) indicate cooling at various times during the mid-late Paleozoic. The petrologic conditions of the Ordovician metamorphism, partial melting of a metapelitic protolith and segregation-ascent-crystallization of the granitic melt occurred along a clockwise P-T-t path at intermediate P, with maximum P of 8 kbar (ca. 25 km) during prograde metamorphisms and peak T of 750 °C (at mid-crustal levels, 5-7 kbar). This evolution is interpreted as the result of a tectonic cycle related to the initial opening of the Rheic Ocean. A second clockwise path at high-P is indicated by high silica muscovite (Si= up to 7.0 atoms pfu), with peak P of ca 10 kbar at ca. 330 °C. This second event did not recrystallize the U-Pb clock in zircons, but it is clearly recorded by a main peak of laser total fusion Ar-Ar analyses on high Si muscovite grains yielding an average of 70.09 \pm 0.5 Ma. This latest Cretaceous stage is related to subduction of the North America plate margin (cover and pre-Mesozoic basement) below the Caribbean Plate and ensuing collision with the Caribbean volcanic arc.

Evolution of magma oceans

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Lord Kelvin's vision of the early molten Earth has been reincarnated after the samples returned by the Apollo missions presented evidence that the Moon might once have been molten. This evidence led to a hypothesis of a lunar magma ocean. The idea of an early molten Earth - the terrestrial magma ocean hypothesis - was developed not long after and rapidly gained a broad acceptance [1]. Magma oceans or magmaspheres of various types on Earth as well as on other terrestrial planets have been proposed [2-8]. The growing list of extrasolar planets now includes planets which currently are likely to be at least partially molten [9]. The hypothesis of magma oceans is undoubtedly among the most important building blocks in the modern narrative of planetary formation and evolution. The major challenge in describing the evolution of magma oceans is that we have to deal with the extreme conditions of planetary interiors where the material properties and global dynamics are poorly understood [10, 11]. Answers to even basic questions concerning whether solid phases sink or float in magma oceans, how long it takes magma oceans to crystallize and where chemical equilibration occurs have been eluding researchers for decades. Yet, these questions are critical for the interpretation of geochemical data, for the understanding of how magma oceans lead to the current planetary structures and to the current dynamic regimes of planetary interiors including the existence of plate tectonics on Earth [12].

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