New U-Pb ages for syn-orogenic magmatism in the SW sector of the Ossa Morena Zone (Portugal)

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The Ossa-Morena Zone (OMZ) is a major geotectonic unit within the Iberian Massif (which constitutes an important segment of the European Variscan Belt) and one of its distinguishing features is the presence of a noteworthy compositional diversity of plutonic rocks. In the SW sector of the OMZ, the tonalitic Hospitais intrusion (located to the W of Montemor-o-Novo) is considered a typical example of syn-orogenic magmatism, taking into account that both the long axis of the plutonic body and its mesoscopic foliation are oriented parallel to the Variscan WNW-ESE orientation. Another relevant feature of the Hospitais intrusion is the occurrence of mafic microgranular enclaves within the main tonalite. In previous works (Moita *et al*., 2005; Moita, 2007), it was proposed that: (1) the Hospitais intrusion is part of a calc-alkaline suite, represented by a large number of intrusions in this sector of the OMZ, ranging from gabbros to granites; (2) the enclaves are co-genetic to the host tonalite in the Hospitais pluton.

In this study, zircon populations from one sample of the main tonalite (MM-17) and one sample of the associated enclave (MM-17E) were analysed by ID-TIMS for U-Pb geochronology. In each sample, three fractions of nice glassy, euhedral, long prismatic and inclusion free crystals were analysed. The results from the three fractions of MM-17 yielded a weighted average $^{206}Pb/^{238}U$ age of 337.0 ± 2.0 Ma. Similarly, for the enclave MM-17E a weighted average $^{206}Pb/^{238}U$ zircon age of 336.5 ± 0.47 Ma was obtained. These identical ages, within error, are in agreement with a common parental magma for the tonalite and mafic granular enclaves.

Similar U-Pb ages have been reported in previous works for plutonic and metamorphic events in this region (e.g.: Pereira *et al*., 2009; Antunes *et al*., 2011). Furthermore, also in the SW sector of the OMZ, palaeontological studies (Pereira *et al*., 2006; Machado & Hladil, 2010) carried out in Carboniferous sedimentary basins containing intercalated calc-alkaline volcanics (Santos *et al*., 1987; Chichorro, 2006) have shown that they are mainly of Visean age. Therefore, magmatism displaying features typical of continental arc setting seems to have been active in this part of the OMZ during the Lower Carboniferous times.

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Water on the primordial Earth

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Water is the medium for life; it facilitates the long-term carbon cycle and aids in plate tectonics by modulating key geophysical parameters such as the mechanical strength of crust. Earth's surface hydrosphere totals 2.8×10^{-4} $M_⊕$, and the mantle may contain $2.7(\pm1.3)\times10^{-3}$ $M_⊕$ of water [1], approximately its storage capacity [2]. Ancient rocks show the hydrosphere existed in the first 700 Myr, and Hadean zircons extend this to about 180 Myr after solar system formation [3]. Earth has retained its volatiles since primary accretion [4], but H- and N-isotopic compositions are chondritic rather than cometary [5]. As such, water may have arrived late in the accretion epoch *viz*. the *Grand Tack* model [GT; 6] or even later via a *Late Veneer* [LV; 7]. The *Late Heavy Bombardment* [LHB] was not significant: it delivered too little (0.1% of the LV's mass), too late. Whether the LV mass (~5×10^{-3} $M_⊕$) was brought in by many small undifferentiated planetesimals or a small number of large differentiated bodies is still an open issue, and we discuss advantages and disadvantages of both options. Such a mass was insufficient to deliver all the water even assuming CI composition. Earth-Moon O-isotopes exclude a CM, CI, or OC composition for the LV; EC composition would be possible but they are so water poor that they cannot explain Earth's water abundance whatever the LV mass. Volatiles were delivered towards the end of Earth accretion rather than via an LHB, LV, or Moon-forming event. This view is consistent with the latest dynamical models provided that Moon formation was fortuitously late [8].

[1] Hirschmann & Dasgupta (2009); [2] Smyth & Jacobsen (2006); [3] Harrison (2009); [4] Albarède *et al*. (2013); [5] Marty (2011); [6] Walsh *et al*. (2011); [7] Albarède (2009); [8] Halliday (2013).

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