Accretion and splitting within the Permian Pangea recorded by episodic metamorphic zircon growth

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Zircon, which is a fairly common accessory mineral, constitutes a robust reservoir for radiogenic Pb and is increasingly used as a U-Pb geochronometer for dating metamorphic events. Where radiogenic Pb-loss has occurred, this is generally explained by processes such as Pb diffusion, α-recoil, closure temperature, fluid circulation, and weathering whose the respective roles are still debated.

U-Pb data obtained using two ion microprobes (CAMECA, IMS 1270 and SHRIMP II) have provided empirical results on U-Pb system behaviour in zircon from a kinzigitic gneiss of Corsica. We found that unaltered zircons are especially robust to Pb diffusion, leading to concordant data with both instruments. Absolutely no relationship appears between U concentration (despite its high range of 200 to 2400 ppm) and individual ages, and no evidence of radiation damage was seen. Conversely, a wide range of concordant ages was observed from 360 to 180 Ma, with up to three significant ages being recorded by a single grain (321±10, 270±14 and 235±4 Ma, 2σ). The statistical distribution of the individual ages demonstrates that two major thermal events in the upper crust were recorded, namely at 240 and 280 Ma —events that were also recorded by zircons from the Ivrea Zone of the southern Alps (Vavra et al., 1999), albeit with a slight diachronism in agreement with the orogenic processes operating during the accretion and opening of Pangea. No age younger than 182±4 Ma was detected, which is in agreement both with the hypothesis of no continuous Pb-loss and with a previous dating for the opening of the ocean basin at 169±3 Ma (Rossi et al., 2002)

We can thus conclude that the U-Pb zircon geochronometer appears more likely to be reset by fluid percolation, if primary crystal defaults and cracks existed, giving rise to amorphous domains and related Pb diffusion, than to be reset by a continuous process related only to U content and subsequent radiation damage. Moreover, the zircon crystal lattice can resist high temperatures in the absence of percolating fluid. Our example shows that U-Pb ages can be interpreted as crystal growth stages and related to geodynamic events.

References

Rossi P., Cocherie A., Lahondère D. and Fanning C.M., C.R. *Geoscience* (in press).

Vavra G., Schmid R. and Gebauer D., *Contrib. Mineral. Petrol.* (1999) 134: 380-404.

Elucidating the Chemical Evolution Of Organic Matter in Carbonaceous Chondrites

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Complementary, double and single resonance solid state (^{1}H and ^{13}C) Nuclear Magnetic Resonance (NMR) experiments were performed on a solvent extracted and demineralized samples of Orgueil, Murchison, and Tagish Lake meteorite insoluble organic material. These NMR data provide a consistent picture of chemically complex solids composed of a wide range of organic (aromatic and aliphatic) functional groups, including numerous oxygen containing functional groups. Notwithstanding the broad range of organic functionality present in each insoluble residue, there exist significant differences in the their relative abundance. For example, the fraction of aromatic carbon (F_a) detected via ^{1}H-^{13}C cross polarization NMR ranges from 0.50 in the case of Orgueil, to 0.61 for Murchison, and to 0.80 for Tagish lake. Single pulse ^{13}C NMR, a method capable of detecting all carbon (whether proximal to ^{1}H or not) yielded F_a's of 0.58, 0.63, and 0.81 for Orgueil, Murchison, and Tagish Lake, respectively. In each case with the exception of interstellar diamond (readily detected in single pulse NMR experiments at 1-2 % total carbon in each residue) there is no evidence for a significant abundance of large laterally condensed aromatic molecules in the insoluble residues.

Employing a different set of NMR experiments we are also able to determine the fraction of aromatic carbon directly bonded to hydrogen in each residue as well as the fraction of aliphatic hydrogen to aromatic hydrogen. It is possible that the all three meteoritic residues share a common origin but differ due to either early or late processes in the solar nebula. Arranging the residues in terms of increasing aromaticity, one can infer from these NMR data that principal chemical changes that may have altered each residue involved the progressive loss of aliphatic carbon with minimal loss of organic oxygen functionality. If these chemical differences do constitute an evolution resulting from alteration processes within meteoritic parent bodies, then this alteration differs considerably from chemical evolutionary trends observed for terrestrial kerogens when subjected to thermal metamorphism. On going studies on additional meteorites will likely aid our understanding of the nature of such processes.