# Swelling induced by alpha decay in monazite and zirconolite ceramics: a XRD and TEM comparative study.

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Zirconolite and monazite are potential ceramics for the containment of actinides (Np, Cm, Am, Pu) produced by reprocessing spent fuel. Alpha decay is the main disintegration mode for actinide elements. This phenomena induces structural changes on the ceramics (amorphisation, swelling…). In order to study these effects two parallel approaches based on external irradiations and short-lived actinides doping ($^{238}$Pu) were used. On one hand, plutonium oxide was incorporated into the monazite and the zirconolite structure. On the other hand, external irradiations with Au ions were used to simulate energy deposits corresponding to the recoil nucleus.

For both irradiations, zirconolite samples become amorphous at room temperature for a critical dose close to 0.3 dpa and the magnitude of the swelling at saturation is similar (about 6%). Ballistic processes are predominant in the damaging of this structure. On the contrary the swelling and the amorphisation of monazite sample depend on the nature of the irradiation. Ion irradiated samples present a saturation swelling close to 7% and are metamict for a critical dose close to 0.3 dpa while the swelling measured on $^{238}$Pu doped samples is only 2% and they remain crystalline up to 7.5 x $10^{18}\alpha$/g, i.e. 0.7 dpa. The different behavior observed between doped and externally irradiated monazite samples can be interpreted in terms of annealing effects induced by ionizing radiation. The ratio electronic-to-nuclear stopping seems to be a key parameter for the damage recombinaison in monazite. Evidence of alpha annealing is observed on the monazite structure.

# Timescales of partial melting and UHP exhumation, Papua New Guinea

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To understand how crustal rocks are subducted to mantle depths and subsequently exhumed, it is crucial to determine the relative timing and relationship of the host migmatites to the UHP–HP eclogites. The Pliocene UHP terrane of southeastern Papua New Guinea (PNG), exposes large areas of migmatitic gneiss within domal structures found throughout the D'Entrecasteaux Islands, including Goodenough, Fergusson, and Normanby Islands. These gneisses reveal abundant evidence for partial melting during exhumation. Zircons analyzed using U-Pb chemical abrasion thermal ionization mass spectrometry (CA-TIMS) geochronology from eclogite suggest UHP metamorphism began at ca. 5 Ma, and Ar-Ar thermochronology indicates exhumation of the rocks to the surface by ca. 2 Ma. To evaluate the role of partial melting in the exhumation of this UHP terrane, U-Pb CA-TIMS geochronology was applied to zircons separated from multiple leucosomes and dikes across the three islands. Previous U-Pb results from the UHP locality and other parts of the western Fergusson Island dome reveal melt-present deformation in the form of foliation-parallel leucosomes with crenulated margins that formed from ca. 3.5–3.0 Ma and weakly-deformed cross-cutting dikes at ca. 2.4 Ma. In comparison, zircons from a similarly deformed foliation-parallel leucosome within Goodenough dome to the west reveal melt crystallization from ca. 4.7–2.7 Ma. The youngest igneous rocks are felsic non-deformed intrusions which contain zircons as young as ca. 1.8 Ma. Finally, in the south, Normanby dome records the development of the host orthogneiss by ca. 5.9 Ma and emplacement of deformed granodiotite sills by ca. 4.1 Ma. Zircons from non-deformed granodioritic and andesitic dikes yield similar crystallization ages to Goodenough Island, with zircons as young as 1.8 Ma. The emplacement of the gneiss domes within the upper crust occurred by ca. 1.9–1.8 Ma, based on the late dikes, and is similar across the entire PNG UHP–HP terrane. The results indicate that exhumation of the PNG UHP–HP terrane was aided by multiple stages of partial melting that increased the overall bouyancy of the subducted crustal material.

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