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Apparent partial resetting of U-Th-Pb systems in experimentally altered monazite resulting from nano-mixtures due to incomplete replacement.

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Hydrothermal alteration experiments of natural monazite crystals (Manangotry, Madagascar; 555 Ma) under alkali conditions (NaOH 1M in 18O doped solution) at low temperature conditions (300, 400, 500 and 600°C), 200 MPa, were conducted to clarify the origin of unsupported Pb (radiogenic or not) in altered monazite (Seydoux-Guillaume et al., 2012). At 300°C, no evidence of monazite replacement was observed. From 400 to 600°C, experimental products show a replacement texture with pristine monazite (Mnz1) surrounded by an alteration rim with a different composition (SEM and EPMA). In the altered domains, in-situ isotopic and chemical U-Th-Pb dating yields intermediate ages between original monazite (555 Ma) and complete experimental resetting (0 Ma). Incomplete resetting is due to the systematic presence of Pb in altered domains, whose concentration decreases with increasing temperature. Transmission Electron Microscope (TEM) observations reveal an incomplete replacement of Mnz1 by a secondary monazite (Mnz2), free of Pb, within the altered domain. The latter domain, apparently homogeneous in BSE images, is in fact constituted by closely associated nano-mixtures of Mnz1 and Mnz2. Furthermore, the volume of Mnz2 within the altered domain, i.e. the efficiency of replacement, increases with increasing temperature. Apparent partial resetting of U-Th-Pb systems results from the unavoidable nano-mixture of different proportion of Mnz1 and Mnz2 within the analytical microvolume (EPMA, LA-ICP-MS). This study therefore indicates that the micrometric resolution (even the 5 μm3 for EPMA) of in-situ dating techniques may be not sufficient to solve such nano-replacement domains, especially when alteration occurs at low-temperature.
Ref: Seydoux-Guillaume, A.-M., Montel, J.-M., Bingen, B., Bosse, V., de Parseval, P., Paquette, J.-L., Janots, E., and Wirth, R., (2012). Chemical Geology, v. 330-331, p. 140–158.