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Measurement of U-Pb ages of uraninite and davidite by laser ablation-HR-ICP-MS

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Abstract

Laser-ablation high-resolution inductively coupled plasma mass spectrometry (LA-HR-ICP-MS) is a rapid, accurate, and inexpensive technique for making in situ U-Pb isotopic measurements of uraninite and davidite. The advantages of this method include: (1) mineral separation and chemical digestion are not required; (2) measurements on complex samples are feasible because significant isobaric interferences can be resolved; and (3) accurate U-Pb and $^{207}Pb/^{206}Pb$ dates on 10–25 μm spots can be obtained rapidly. The LA-HR-ICP-MS method is applied to U oxide minerals from four deposits and prospects from northern Australia, and the new dates are compared to previously published conventional thermal ionization mass spectroscopy (TIMS) dates, and to known ages of geologically important events. These comparisons permit us to assess elemental fractionation of U and Pb for uraninite and davidite of the new method, relative to zircon, as well as its geochronological accuracy and precision. U-Pb apparent ages measured previously agree well with our measurements for El Sherena, Palette, and Mt. Isa. Additionally, the upper-intercept $^{207}Pb/^{206}Pb$ dates for Adelaide River (701 ± 190 Ma, 1σ) and Palette (841 ± 94 Ma, 1σ) uraninite, measured here, are similar to those previously obtained for Palette (730 Ma), Nabarlek (920 Ma), and Koongarra (870 Ma), and the upper-intercept date for El Sherena uraninite (1573 ± 160 Ma) is within error of that previously determined for Ranger (1550 ± 15 and 1472 ± 40 Ma). Such apparent-age agreement for uraninite (and similarly for davidite) indicates that U and Pb fractionations are within error of that for zircon, whereas the inherent imprecision of our dates and their associated MSWD values greater than 2.5 probably indicate that multiple resetting events affected our samples. Analytically, these results demonstrate that the LA-HR-ICP-MS technique provides excellent spatial resolution while also removing argide, phosphide, sulfide, and halide interferences that can otherwise lead to erroneous data when using quadrupole-ICP-MS. Geologically, the individual $^{207}Pb/^{206}Pb$ and upper-intercept U-Pb dates of uraninite from Adelaide River and Palette are ca. 800 Ma, possibly reflecting recrystallization of uraninite during the break-up of Rodinia.

Keywords: U-Pb age, Pb-Pb age, laser ablation, HR-ICP-MS, uraninite, davidite, Australia, U-deposit