‘Zir-Chron’ — an online application for exploring the science of U-Pb zircon geochronology

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U-Pb zircon geochronology has proliferated over the past two decades as a tool for understanding Earth systems dynamics, spurred by developments including rapid, inexpensive analysis by laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS), and a renaissance in high-precision isotope dilution thermal ionization mass spectrometry (ID-TIMS). A result is that many users of U-Pb zircon geochronology are no longer deeply invested in the analytical measurements themselves (the geochronometry), nor intimately familiar with the physical models and assumptions that are applied to transform measured isotope ratios into geologic age interpretations (the geochronology).

As part of a series of online activities to teach the science of geochronology, we built an on-line Javascript and HTML-based application that allows students to explore real LA-ICPMS and ID-TIMS data sets. The app is designed around a clickable montage of high-resolution cathodoluminescence images showing the growth zoning of zircon crystals. Students select what analysis mode to explore (LA-ICPMS or ID-TIMS) and incrementally choose a set of spots or crystals to analyze by clicking appropriately; with each click the actual U-Pb date and its error measured for that spot or crystal appear in a tabulated list, and are displayed in both histogram and summed probability density function graphical formats. The inverse-variance weighted mean, standard error, and probability of fit parameters are automatically calculated and displayed for the group of spots or crystals selected.

We provide an example curriculum for use of this app in exploring the criteria by which crystals from a population are selected, the use of basic parametric statistics to establish the precision and accuracy of U-Pb zircon ages, and the strengths and weaknesses of different analytical techniques. The curriculum is flexible and can be deployed at lower division undergraduate through to advanced graduate levels. The portability of the application across platforms and mobile devices readily allows for customizing its use in varied classroom and on-line settings. The data sets to be demonstrated are produced from Oligocene volcanic tuffs of the John Day Formation in Oregon, however the open-source nature of the app allows customization with different images and data sets for users with a basic knowledge of HTML.