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Coupling of Imaging Mass Spectrometry and High Resolution U-Th-Pb Geochronology on Carbonates for the Earth Genomics

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Time-resolved elemental and isotopic data can provide key information about the time changes in the surface geochemical conditions of the Earth, and therefore, critical restriction for the origin and the evolutional sequence of the life on the Earth could be evaluated. To obtain reliable and exclusive information from the samples, tremendous efforts have been made to improve both the analysis spatial resolution and the precision in the resulting ages. Especially for the young samples, correction of isotope disequilibrium is still key issue to obtain reliable age data. Recently, we have developed new correction method for the initial disequilibrium, and therefore, application range for the U-Th-Pb geochronology could be remarkably extended to the young samples (e.g., $<$0.1 Ma). The U-Th-Pb age determinations have been widely applied for the U-Th-bearing mineral such as zircon, monazite or apatite, which would have high closure temperatures for the U-Th-Pb decay series isotopes. Despite the obvious success in obtaining reliable age data for these U-Th bearing minerals, age determination for other minerals of different closure temperature is highly desired. Many geologists are increasingly interested in processes in rocks that operate under the lower temperatures. To achieve this, we have focused on the U-Th-Pb age determinations for carbonates. The in-situ U-Th-Pb age determinations for carbonates have been retarded mainly due to very low U-contents in the carbonates (e.g., $<$1 ug/g). Moreover, system closure could be easily lost through the geological time. To measure precise Pb/U and Pb/Th isotope ratio from the carbonates, coupling of laser sampling and the high sensitivity ICPMS system was employed. Hence, all the ^{202}Hg, ^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb and ^{238}U signals were simultaneously measured using six high-sensitivity ion multipliers. This multiple collector (MC) system provides much higher duty cycle over the traditional isotope ratio measurements. Sensitive in-situ U-Th-Pb isotope ratio measurements can be made directly from the solid minerals using the present analytical technique. Despite this, there still remains a problem of both the contamination of non-radiogenic Pb and the secondary loss of the radiogenic-Pb, which were the major source of the resulting age values. To overcome this, prior to the age determination analysis, elemental mapping or distribution feature of all U, Th and Pb isotopes were measured to evaluate the magnitude of the secondary loss or contamination of U, Th and Pb isotopes.

With the LA-ICPMS technique, elemental imaging analysis can be made from fairly large-sized samples (e.g., $>$20 mm x 20 mm), and thus, the comprehensive information concerning the secondary distribution of the trace elements can be evaluated from whole sample bodies. Combination of elemental imaging and the U-Th-Pb age determination, together with the correction technique for the initial disequilibrium, can provide precise and reliable age data from the carbonatets. The details of the analytical procedure and the correction technique for the initial disequilibrium will be discussed in this presentation.

Keywords: U-Th-Pb dating, Multiple collector-ICPMS, Laser ablation, Elemental Imaging, Earth Genomics