Multi-stage evolution and fluid activity of HP-UHP rocks from the western Dabie Mountain, central China: Evidence from zircon trace element, U-Pb age and Hf isotope composition

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The Dabie-Sulu UHP terrain is the largest UHP orogen on earth. Despite intensive study for more than 20 years, controversies still exist about the location and number of sutures and the timing of collision and their subsequent evolution. The Hong'an Block, that forms part of the western Dabie Mountains, is one area critical to decipher the tectonic evolution of the Qinling-Dabie-Sulu orogenic belt, as it is located at the junction between the western and eastern sections of the orogenic belt, and forms the transition between zones exposing low-pressure and ultra-high pressure rocks.

Zircon trace element, U-Pb age and Hf isotope composition were determined for HP and UHP rocks from the Huwan HP and the Xinxian UHP units in the western Dabie Mountains. The results demonstrate that a Carboniferous eclogite-facies metamorphism in Siluro-Devonian oceanic protoliths occurred in the Huwan HP zone. Whereas the UHP rocks from the Xinxian UHP zone were mostly derived from the Neoproterozoic basement rocks in Yangtze Block, and have experienced prograde and retrograde eclogite-facies metamorphism at 239 ± 2; 227 ± 2, and 216 ± 3 Ma, respectively. They can be used to constrain a two-stage exhumation process with average exhumation and cooling rates at ca. 0.33 cm/y and 8 °C/ Ma and at 0.67 cm/y and 65 °C/ Ma. Two episodes of fluid activity have also been dated for quartz veins within around eclogites at 224.7 ± 1.3 and 217 ± Ma, which might have been accompanied with the two periods of exhumation process of the UHP rocks.

Noninvasive geophysical imaging of ureolytic $CaCO_3$ precipitation

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Calcium carbonate ($CaCO_3$) minerals are a key family of compounds that frequently precipitate during natural and engineered subsurface processes. Carbonate precipitation has utility in both environmental remediation, as a means to sequester hazardous radionuclides including Strontium 90, and in geotechnical engineering as a tool for improving soil strength or decreasing rock permeability. Characterization of both the spatial extent and temporal dynamics of subsurface precipitation is critical for both of these applications.

Wellbore geochemical sampling is the currently accepted monitoring strategy for stimulated precipitation experiments. However, the spatial and temporal variability of the induced process often make it difficult to assess the efficacy of the treatments over time and space using wellbore data alone. Recent studies have explored the potential of geophysical, especially electrical and seismic, methods as monitoring tools for induced precipitation processes during bioremediation. Specifically, distinct electrical signatures have been observed during abiotic precipitation of well crystalized calcite. The combination of wellbore geochemical sampling and spatially extensive geophysical data could significantly improve our understanding of the evolution of induced *in situ* precipitation processes.

Urea hydrolysis is one mechanism used to induce *in situ* $CaCO_3$ precipition. Here, we explore the electrical and seismic signatures produced by ureolytic $CaCO_3$ precipitation using the model organism *Sporosarcina Pasteurii*. Our data revealed a significant increase in electrical signatures due to $CaCO_3$ precipitation, and changes in both P-wave seismic attanuation and velocity corresponding to the initiation and accumulation of $CaCO_3$ over time. Calcium concentration was monitored regularly and used to calculate precipitate mass and establish petrophysical correlations to geophysical attributes. Postmortum scanning electron microscopy (SEM) revealed the size and morphology of the precipitates which differered significantly from previous abiotic experiments.

Our results demonstrate the sensitivity of electrical and seismic methods to microbial $CaCO_3$ precipitation and suggest a complementary geophysical approach for monitoring induced *in situ* precipitation treatments.