

He-Ar isotope composition in pyrite and wolframite of Tieshanlong tungsten deposit, Jiangxi, China

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Tieshanlong is a large quartz vein type wolframite deposits in southern Jiangxi, South China, and was genetically related with high potassium S-type granite. Seven pyrite and two wolframite samples were selected for determining He and Ar isotope compositions, which yielded the results of ³He/⁴He values from 0.04 R_a to 0.98 R_a, ⁴⁰Ar/³⁶Ar from 293.5 to 368.0, and ³⁸Ar/³⁶Ar from 0.176 to 0.193. These values indicate that the ore-forming fluid is not only from simple mixing of the crust and mantle end-members, but addition of meteoric water. Further study reveals that little mantle helium was added during the crust re-melting process when granitic magma was generated. On the other hand, the re-melted crust material was mainly terrestrial clastic sediments, which contain sufficient surface water and hence showing present He-Ar isotope composition of stronger meteoric heritage but not typical 'crust fluid' feature. It is postulated that boiling and second mixing with new meteoric water took place when the fluid migrated into the wall-rock fractures, resulting in drastically decreasing of its metal transport capacity, causing precipitation of quartz and wolframite.

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Reactive transport modeling of ureolytic calcite precipitation using a parallel, fully coupled approach

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One potential remediation strategy for trace metal and radionuclide contaminants in the subsurface is engineered precipitation of minerals that can immobilize metals. One example of such a strategy is calcium carbonate mineral precipitation facilitated by urea hydrolysis to immobilize contaminants such as strontium-90 by co-precipitation. Multiple processes including fluid flow, transport of reactants, biogeochemical reactions and resulting porosity-permeability changes are involved and tightly coupled at various scales. Numerical models have often been used to investigate the nonlinear coupling effects of these processes which are extremely difficult to explore experimentally. Most existing reactive transport simulators typically employ an operator-splitting approach. However, such an approach has limited applicability for many biogeochemical systems with fast kinetics and strong medium property-reaction interactions.

We have developed a parallel, fully coupled, fully implicit reactive transport simulator with advanced computing capabilities such as adaptive mesh refinement (AMR) and using state of art nonlinear and linear solvers. The system of transport and reaction equations is solved simultaneously in a fully coupled, fully implicit manner. The simulator was applied to model reactive transport in a 1d column where conditions that favour calcium carbonate precipitation are generated by urea hydrolysis catalyzed by urease enzyme. The modelling results were compared to both laboratory experimental data and simulation results obtained using the reactive transport simulator STOMP. The comparisons clearly demonstrate the advantages of fully coupled approaches for accurate simulation of strongly coupled processes such as engineered mineral precipitation in the subsurface.