Geochemical info of trace elements for the ore-forming process of ore-body 59 in the Shifengshan copper deposit, Yimen, Yunnan, China

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The ore-body 59 is strongly oxidated, locally including vein and spotted sulphides. Samples were tested with ICP-MS method. Element frequency distribution models show 3 groups: Cu-MgO-Sr-Co-V-Pb, K_2O-Na_2O-Mn-Mo-Ba, Cu-Zn-Bi. R-factor analysis produces 6 factors: petrogenic elements F_1 (Rb, Ti, Li, K_2O, Ba, Na_2O, ∑LREE), Cu-mineralization F_2 (-Sr, -MgO, -CaO; Bi, W, Zn, Cu), hydrothermal effects F_3 (Sn, Cr, Tl, Ni, Na_2O) and F_6 (Ge-Co-Ni), Zn-Pb-Cu-mineralization F_4 (Zn, Cd, Pb, Mo, Cu). Q-cluster analysis gives 4 groups: Zn- Cu -Mo-Pb mineralization group, K_2O-Ti-Ba-V-Na_2O in-coming exhalative elements, Cr-Ni basic elements, CaO-MgO-Sr-Mn wall rock elements. The geochemical anomaly sections present groups as CaO-MgO-Sr, K_2O-Na_2O-Ba, Zn-Cu-Pb-Bi, Cr-Co-Ni-W, Ti-V-Be-Mo. These results reveal at least two Cu-sources. Cu-mineralization elements were brought in by the K-Na-Mn-Mo-Ba-bearing fluids during the diapir forming; Secondly, Cu mineralization elements flowed in with the Cr-Co-Ni-bearing fluids by tectonic reformation and basic magma superimposition. Wall rocks provided few matellogenic materials. During the upthrust of Cu-bearing diapirs, fluids extracted matellogenic materials of Cu-Zn-Bi-W elements to form ores in the faded dolomite rocks; Subsequently, Cr-Ni and Cu-Pb-Zn were orderly concentrated, which reworked the early ore veins; The latest stage of underground hydrothermal fluids leached the sulphide ores to form the oxidated ore-body.

Gas character anomalies found in highly productive shale gas wells

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Stable carbon isotope compositions of natural gases allow for numerous useful interpretations including the identification of "families", observing seals, detecting overpressure, and providing evidence of migrated thermogenic gas accumulations. In shale gas plays, where the source rock is also the reservoir, carbon isotopes of ethane and propane are robust thermal maturity indicators and can be accurately calibrated against measured vitrinite reflectance values. The calibration is particularly useful when coupled with mud gas isotope analyses where gas samples from the mud stream are collected at specific depths and used to generate a "thermal maturity" log.

Stable carbon isotopes become increasingly heavier (more positive) with increasing maturity. However, in certain shale gas plays (including the Haynesville, Barnett, Fayetteville, Woodford and Marcellus) an interesting phenomenon occurs at high maturity where the ethane and propane isotope values begin to reverse and become lighter (more negative) than methane values. In these highly mature shale environments, laboratory testing suggests that *in situ* wet gas cracking occurs where larger molecules crack into smaller molecules with lighter isotopic signatures.

A key observation is that many of these "isotopically reversed" wells appear to be the most productive. One possible advantage might be higher reservoir pressures associated with an increase in the concentrations of smaller gas molecules. Furthermore, if the shale has moved past the kerogen and oil cracking stages to reach the wet gas cracking maturity level, the kerogen/shale is likely more brittle with increased porosity and permeability.

Gas isotopes are also used as a proxy for shale porosity and permeability. Large carbon isotopic shifts between mud and headspace gases correlate with zones of increased porosity and permeability. In conjunction with traditional logs, these data can be used to pick horizontal drilling positions and fracture intervals.