Cu and Fe Isotope Variation in Candelaria Sulfides: Tracing to Origin of Fluid Components in a Stratiform Ore Deposit

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We have used LA-MC-ICPMS to determine Cu and Fe isotope ratios in chalcopyrite and pyrite from a stratigraphic section through the stratiform Candelaria Cu-Au deposit. Chalcopyrite ε^{65}Cu range from -11 to +6 (n = 85), many of which are ^{65}Cu depleted when compared to chalcopyrite from igneous porphyry systems. However, chalcopyrite from the Candelaria open-pit have ε^{65}Cu overlapping porphyry systems, suggesting an igneous source for the Cu in the massive ore. Very low ε^{65}Cu in sequences above the Candelaria open-pit may reflect the vapor transport of Cu, or fluid mixing. Chalcopyrite ε^{57}Fe range from -22 to +4 (n = 102), but the majority cluster between -22 and -8, and are indistinguishable from those in porphyry deposits. In contrast, the ε^{57}Fe of pyrite (n = 111) show a bi-modal distribution, with ε^{57}Fe ranging between -25 to -10 and -2 to +15. The high ε^{57}Fe are indistinguishable from igneous porphyry pyrite ε^{57}Fe = 0 to +12) and provide unambiguous evidence for the involvement of an igneous component in Candelaria ore genesis. However, the low ε^{57}Fe pyrites also suggest the involvement of another Fe source. Three samples, from the west, central and eastern zones of the Candelaria open-pit show evidence for interaction between the igneous and, presumably, crustal fluids. Chalcopyrite and pyrite from the western-most sample, near a shear zone, have Cu and Fe isotope variations similar to those observed in igneous porphyry deposits. In contrast, chalcopyrite and pyrite from the eastern-most sample, near a major fault, have an igneous-like ε^{65}Cu, but the chalcopyrite and pyrite ε^{57}Fe are unlike that observed in porphyry systems. The Cu and Fe isotope variations of the central sample are intermediate between the western and eastern samples. These variations undoubtedly result from mixing between Fe from an igneous fluid from the shear zone and Fe from a crustal fluid from the fault zone.