

Crustal Affinities of Metallogenesis in the American Southwest

SPENCER R. TITLEY

Department of Geosciences, University of Arizona, Tucson, Arizona 85721

Abstract

The source of metals in many kinds of ores and ore deposit styles remains uncertain, notwithstanding more than a century of field studies, scientific advances in concepts, and enhancement of analytical capability. However, numerous geologic research efforts that have addressed many relevant themes in southern Arizona have resulted in different kinds of data supporting and consistent with the interpretation of significant association of some ore metals of this region with cratonic crust. These themes range in scale from studies of regional geology, geophysical interpretations, and precious metal production through petrology to trace element and isotope geochemistry. The notion of a crustal source for metals contrasts with many long-standing ideas of direct mantle sources for this metal province, or more recently, direct derivation of metals from subducted materials. A hundred years of recorded silver and gold production reveal a two-fold separation of mining districts in Arizona and New Mexico, on the basis of ranges of produced Ag/Au ratio that correspond in turn with a separation of two distinct geologic domains of the southern cordilleran metal province. The produced Ag/Au ratio in districts of different ages, ore styles, tectonic setting, and metal habit are not affected by deposit style or ore control, or igneous rock type, or vertical zoning and weathering. Studies of the isotopes and trace element chemistry of related igneous rocks reveal that ore-related intrusions have a significant crustal progenitor. Studies of Pb and Os isotopes have discovered strong signals of crustal parentage in ore minerals. The regional geology, metallization history, production, and chemical and isotopic data strongly support a hypothesis of crustal sources of some of the metal in this large and complex province.