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Title: GEOCHEMICAL MASS-BALANCE MODELING OF THE UPPER CRUST OF THE ARIZONA PORPHYRY COPPER PROVINCE, RAY REGION, SOUTHEAST ARIZONA: INITIAL RESULTS

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Abstract: To what extent are porphyry mineral deposits influenced by and to what extent do they affect the geochemical character and evolution of the crust into which they are emplaced? Rocks of the Ray region, southeast Arizona, are ideally suited for addressing this question, because they are representative of the Arizona porphyry copper province and well exposed in several strongly tilted crustal blocks. To elucidate the geochemical evolution of the Ray region, we have assembled a database of 157 major- and trace-element analyses (141 new) of rocks and sediments in the Ray region—the Grayback, Kearny, Sonora, and Teapot Mountain and 15´ quadrangles. Sampled units include 1.7-Ga Pinal Schist and Madera Diorite; 1.4-Ga Ruin Granite; 1.1-Ga Apache Group and diabase; Paleozoic strata; Late Cretaceous to early Paleogene ("Laramide") basaltic andesite, diorite, and granodiorite–granite; and late Paleogene to Neogene sedimentary rocks. We have modeled the upper 10 km of the Laramide and older crust of the Ray region as comprising four major units: Pinal Schist (22%), Ruin Granite (38%), Laramide diorite (8%), and Laramide granodiorite–granite (17%). Each of the other five pre-Laramide units makes up 1–6 % of the model crustal column. All geologically reasonable combinations of the four major units yield geochemically similar results. Laramide Cu-Mo deposits make up ~ 0.05 % of the model crust, and associated hydrothermally altered rocks ~ 10 %.

Using this model upper crustal column, we have estimated the distribution of each chemical element among geologic units. For example, ~ 90 % of Pb resides in only three units: Pinal, Ruin, and Laramide granodiorite–granite; ~ 90 % of Zn resides in these three units plus Laramide diorite. Five units—Pinal, Ruin, diabase, and Laramide diorite and

granodiorite–granite—account for 85 % of Cu in the model crust outside the ore deposits. The several porphyry deposits of the Ray region contain about 12 % of the total inventory of Cu, and about 4 % of the total Mo. Nearly all of the As is hosted by just three units: Ruin, Apache, and Paleozoic. Whether As in the two sedimentary units is syngenetic or epigenetic remains uncertain. About half of the Cr and Ni reside in the Pinal Schist alone, reflecting the continental margin setting of its protolith.

The Ruin Granite, with affinities to A-type granites, is geochemically distinctive in that it has large concentrations of a diverse suite of lithophile and chalcophile elements. Because of this peculiar composition and its large fraction in our model crust, the Ruin alone contains ≥ 55 % of the total inventory of many elements: Rb, Cs, HREE, Th, U, Nb, Mo, W, In, Tl, Sn, Pb, Sb, and Bi.

So far, our modeling suggests that the Cu-Mo deposits of the Ray region contain ~ 5–10% of total upper crustal Cu and Mo. Neither pre-Laramide nor Laramide rocks are especially enriched in Cu or Mo, suggesting that the upper crust of this region is not geochemically special.