©2004 by *Economic Geology*
Vol. 99, pp. 1085–1106

Metal Sources in Mineral Deposits and Crustal Rocks of Ecuador (1° N–4° S): A Lead Isotope Synthesis

MASSIMO CHIARADIA,[†*]

Section des Sciences de la Terre, University of Geneva, Rue des Maraîchers 13, 1205 Geneva, Switzerland

LLUÍS FONTBOTÉ,

Section des Sciences de la Terre, University of Geneva, Rue des Maraîchers 13, 1205 Geneva, Switzerland

AND AGUSTÍN PALADINES

FIGEMPA, Universidad Central del Ecuador, Quito, Ecuador

Abstract

Ecuador consists of terranes having both continental (Chaucha, Tahuin, Loja terranes) and oceanic (Macuchi, Alao, Salado terranes) affinity, which were accreted to the Amazon craton from Late Jurassic to Eocene. Four main magmatic arcs were formed by the subduction of the Farallon/Nazca plate since the Jurassic: a Jurassic continental arc on the western margin of the Amazon craton, a Jurassic island arc (Alao terrane), an early Tertiary island arc (Macuchi terrane), and a middle-late Tertiary continental arc encompassing the terranes of Macuchi, Chaucha, Tahuin, Loja, and Alao after complete assembly of the Ecuadorian crust. Mineral deposits formed during these magmatic arc activities include porphyry-Cu and gold skarn deposits in association with the Jurassic continental arc, polymetallic volcanic-hosted massive sulfide deposits (VHMS) in association with the Jurassic island arc of Alao, Au-Cu-Zn VHMS deposits in association with the early Tertiary island arc of Macuchi, and porphyry-Cu and precious-metal epithermal deposits in association with the middle-late Tertiary continental-arc magmatism on the newly assembled crust of Ecuador (Macuchi, Chaucha, Tahuin, Loja, and Alao terranes). In this study, we have compiled 148 new and 125 previously published lead isotope analyses on Paleozoic to Miocene metamorphic, intrusive, volcanic, and volcanosedimentary rocks, as well as on Jurassic to Miocene magmatic-related ore deposits of Ecuador. Lead isotope compositions of the magmatic rocks of the four main arc events derive from mixing of various sources including mantle, variably enriched by pelagic sediments and/or by a high $^{238}U/^{204}Pb$ component, and heterogeneous continental crust rocks.

Lead isotope compositions of the Ecuadorian ore deposits display a broad range of values ($^{206}Pb/^{204}Pb$ = 18.3–19.3, $^{207}Pb/^{204}Pb$ = 15.54–15.74, $^{208}Pb/^{204}Pb$ = 38.2–39.2), which is as large as the range previously reported for all magmatic-related ore deposits of the Central Andean provinces I and II combined. Ore deposits formed before complete assembly of the Ecuadorian crust through complete accretion of the several terranes (i.e., pre-Eocene) have lead isotope compositions overlapping those of the associated magmatic rocks, suggesting a largely magmatic origin for their lead. In contrast, post-assembly ore deposits (i.e., post-Eocene) have lead isotope compositions that only partly overlap those of the coeval magmatic rocks of the continental arc. In fact, several ore deposits have lead isotope compositions shifted toward those of the basement rocks that host them, suggesting that lead derives from a mixture of magmatic lead and basement-rock lead leached by hydrothermal fluids.

Most Ecuadorian ores have high $^{207}Pb/^{204}Pb$ values (>15.55), suggesting a dominant continental crust or pelagic sediment origin of the lead. However, we caution against concluding that chalcophile metals (for example, Cu and Au) also have a continental crust origin.

Ore deposits of the different terranes of Ecuador, irrespective of their age, plot in distinct isotopic fields, which are internally homogeneous. This suggests that lithologic factors had an important control on the lead isotope compositions. Ultimately, lead isotope compositions of the ore deposits of Ecuador mirror the isotopic compositions of the rocks of the host terranes and are consistent with the multiterrane nature of the Ecuadorian crust.

[†] Corresponding author: e-mail, M.Chiaradia@earth.leeds.ac.uk
[*] Present address: Centre for Geochemical Mass Spectrometry, School of Earth Sciences, University of Leeds, Leeds LS2 9JT, U.K.

0361-0128/01/3448/1085-22 $6.00