

Weathering and transport of Cr and Ni in northern California soils

JEAN M. MORRISON^{1*}, MARTIN B. GOLDBERGER¹,
LOPAKA LEE², JOANN M. HOLLOWAY¹
AND RICHARD B. WANTY¹

¹US Geological Survey, Denver, CO 80225 USA
(*correspondence: jmorrisson@usgs.gov)
(mgold@usgs.gov, jholloway@usgs.gov,
rwanty@usgs.gov)

²US Geological Survey, Hawaii Volcanoes National Park, HI
96718 USA (rlee@usgs.gov)

Geologic, geomorphic, hydrologic and anthropogenic controls on soil geochemistry were investigated across a 22,000 km² area including the Sierra Nevada, the Sacramento Valley, and the northern Coast Range. The results indicate that soil geochemistry in the Sacramento Valley is primarily controlled by the transport and weathering of parent material from the Coast Range and Sierra Nevada. Ultramafic (UM) rocks crop out extensively in both ranges and these rocks and associated soils have high concentrations of Cr and Ni. Soils derived from these UM rocks contained 1700 to 10,000 ppm Cr and 1300 to 3900 ppm Ni. Valley soils west of the Sacramento River contained 80 to 1420 ppm Cr and 65 to 224 ppm Ni, reflecting significant contributions from UM sources in the Coast Range. Valley soils on the east side of the Sacramento River contained 30 to 370 ppm Cr and 16 to 110 ppm Ni, which reflects a dilution of UM material by granitic weathering products from the Sierra Nevada.

Petrographic, XRD and SEM studies show that Cr occurs in UM rocks and soils as Cr(III) hosted by the refractory minerals chromite and other mixed composition spinels containing Al, Mg, Fe, and Cr. Evidence of spinel dissolution is seen in SEM analysis of soils. We defined a Cr reactivity index as the ratio of the Cr concentration determined by a 4-acid digestion (HNO₃, HCl, HF, HClO₄), which does not completely dissolve chromite, to that determined by lithium metaborate fusion (LiBO₃), which gives total Cr content. A higher reactivity index in valley soils suggests Cr is in a more labile form in the valley soils relative to UM sources. Additionally, clays (<2 μm fraction) in valley soils were enriched in Cr and Ni relative to the bulk soil (<2 mm), whereas clays in UM soils were lower in Cr and Ni relative to bulk soils. Regional groundwater data shows elevated Cr(VI) content west of the Sacramento Valley (up to 500g L⁻¹), suggesting that a redox mechanism occurs in the release of Cr from solid phases. Our results show that regional-scale transport and weathering of UM constituents has resulted in enrichment of Cr and Ni in Sacramento Valley soils and a change in the residence of these elements.

Calcite nucleation and epitaxial growth from high ionic strength NaCl solutions

JOHN W. MORSE^{1*}, DAVID W. FINNERAN¹,
KATHERINE WALTON¹ AND ROLF S. ARVIDSON²

¹Department of Oceanography, Texas A&M University,
College Station, TX 77843, USA
(*correspondence: morse@ocean.tamu.edu)
(dfinneran@ocean.tamu.edu,
katherine_walton@ocean.tamu.edu)

²Department of Earth Science, Rice University, Houston, TX
77251, USA (rsa4046@ruf.rice.edu)

The concentration of NaCl was varied from 0.5 to 5 molal in solutions containing low Ca²⁺ concentrations (~10⁻² m) and the supersaturation with respect to calcite was adjusted by varying carbonate alkalinity and pCO₂. Iceland spar calcite was used as the host substrate for epitaxial overgrowth experiments.

Calcite did not nucleate directly from solution, but instead formed on the surface of homogeneously precipitated vaterite crystals. No aragonite was observed. Subsequently vaterite recrystallization initially produced euhedral, well-formed calcite rhombs up to tens of microns in size. Further reaction of this calcite in supersaturated solutions produced surface roughening, macro steps and an increase in kink distribution, suggesting a different growth mechanism.

Epitaxial calcite growth on Iceland spar calcite produced a variety of different surface structures that changed with time and degree of supersaturation. The most common overgrowth was submicron crystals that formed incomplete layers in a manner characteristic of surface instability. Overgrowth layers were often observed to inherit macroscopic surface patterns of the underlying host calcite substrate. Longer reaction times (months) produced extensive recrystallization and heterogeneous evolution of large surface features.