# $^{36}$Cl in a soil in the hyperarid Atacama Desert

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$^{36}$Cl produced *in situ* in rocks has advanced the dating of landforms. Additionally, $^{36}$Cl is produced in the atmosphere by the spallation of $^{40}$Ar, with an average deposition of 6 to 22 x $10^8$ atoms $^{36}$Cl m$^{-2}$ y$^{-1}$ [1]. Finally, atm $^{36}$Cl was produced by thermonuclear weapons testing. Phillips (2000) calculated the bomb fallout of $^{36}$Cl at Antofagasta, Chile to be 5 x $10^{12}$ atoms m$^{-2}$. This exceeds natural deposition rates by 4+ orders of magnitude.

Here, we examine the Cl and $^{36}$Cl content of an ancient (2.1 Ma) soil in the one of the driest regions of the Atacama Desert. Since the late Pliocene, the soils have not lost Cl and $NO_3$ by leaching, and thus have retained both atmospherically and *in situ* produced $^{36}$Cl. Because of this unique setting, we have measured the Cl and $^{36}$Cl content of atmospheric deposition and in soil layers from the surface to a depth of 2 m in order to begin to decipher the relative roles of atmospheric inputs vs. *in situ* production over My timescales. Also, the identification of the bomb $^{36}$Cl will allow us decipher solute leaching on decadal, or shorter, time scales. We use a simple box model to determine if the age of the soil, combined with measured and calculated production rates, explain the general features of the $^{36}$Cl inventory.

[1] Phillips, F.M. (2000) Chlorine-36. In, *Environmental Topics in Subsurface Hydrology*. (Cook, P.G., and Herzog, A.L., eds) Kluwer Academic, Boston, pp. 299-348.

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# Native antimony in hydrothermal gold deposit, Western Junggar (Xinjiang, NW China)

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Geological research and mineral exploration in Xinjiang are developing fast recently [1, 2]. Both Baogutu porphyry Cu-Au deposit [3] and many hydrothermal gold deposits in Western Junggar formed during Late Carboniferous period. For example, the Baogutu gold deposit and Hatu gold deposit are hosted in Lower Carboniferous volcanic-sedimentary strata. The Hatu gold deposit consists of quartz vein type orebody in shallow part and alteration-type orebody in deep part [4], with host rock consisting of tuff and basalt of Early Carboniferous. A zircon SHRIMP age of 328Ma was obtained for the tuff [5]. The Baogutu gold deposit is composed of sulfide-quartz veins and sulfide-quartz vein-nets, with host rock of tuff siltite of Early Carboniferous. The Baogutu gold deposit locates nearby Baogutu porphyry Cu-Au deposit. The major metal minerals in Baogutu gold deposit are native gold, pyrite, arsenopyrite, stibnite and native antimony.

The ore-forming process of Baogutu gold deposit can be divided into three stages: coarse grain quartz stage I; fine grain quartz-sulfide stage II; and calcite stage III. Stage II is the main period for gold deposition, during which formed mineral assemblage of arsenopyrite - arsenic pyrite - pyrite - native gold. Temperature (270~350°C), sulfur fugacity ($\log fS_2 = -8\sim-12$) and Oxygen fugacity ($\log fO_2 < -36$) of stage II are estimated based on the mineral assemblage and composition thermometer of arsenopyrites. Native antimony is scarce, especially in quartz vein type gold deposit. Native antimony, formed at the late stage of Baogutu gold deposit, coexists with stibnite and calcite or replaces stibnite. The native antimony consists mainly of Sb (96% to 97%) and As (2% to 2.5%). Arsenopyrite- pyrrhotite- native antimony- stibnite mineral assemblage formed during the late stage at 240~280°C with $\log fS_2$ of $-12\sim-14$ and $\log fO_2$ of $<-38$.

The temperature and sulfur fugacity of hydrothermal fluid decrease from stage II to III. We conclude that Sb is transported in the form of $HSb_2S_4^-$ in fluid. At the beginning of stage III, pyrrhotite and stibnite formed due to the decrease of sulfur fugacity, caused by the crystallization of arsenopyrite, pyrrhotite and stibnite. This process facilitated the crystallization of native antimony.

[1] Zhu & Song (2006) *Acta Petrologica Sinica* **22**, 135-144. [1] Zhu *et al.* (2006) *Geology in China* **33**, 487-496. [2] Zhu *et al.* (2007) *Acta Petrologica Sinica* **23**, 1739-1748. [3] Song *et al.* (2007) *Acta Petrologica Sinica* **23**, 1981-1988. [4] An & Zhu, (2007) *Mineral Deposits* **26**, 621-633. [5] Wang *et al.* (2007) *Geological Journal of China Universities* **13**, 590-602.