

e-Os dating of the porphyry copper deposits in southern Gangdese metallogenic belt, Tibet

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The southern Gangdese block of Tibet is well characterized by its widely distributed magmatic rocks, especially granitic rocks. Many geologists have made lots of surveys and published a number of papers about the tectonics and geological history of the block. However, significance of granitoid-related copper mineralization was not recognized until recently. The porphyry copper deposits were discovered in the central portion of the southern Gangdese block. The representative deposits include the Chongjiang, Tinggong and Dabu porphyry copper deposits in the region between Rikazi and Lhasa. The ore minerals of the copper deposits are spatially related two kinds of granitoid rocks, including porphyritic granodiorite and granodioritic porphyry. The porphyritic granodiorite occurs as a batholith, with the granodioritic porphyry intruded as dikes. The porphyritic granodiorite is much similar to the regional granitoid rocks both in texture and in composition, which is known as the product of plate collision period (60-30 Ma). The granodioritic porphyry is much later with an isotopic age of 17.1 Ma (Geological Survey of Tibet, unpublished), and recognized as the product of deducting and rifting of Gangdese block. Which one of the two kinds of granitoid rocks is metallogenically related to the copper mineralization has been argued among the researchers for a long time. Due to the large difference between the granitoid rocks ages, dating the copper mineralization would be helpful for determination of the source rock, and for further regional porphyry copper targeting. Re-Os dating of molybdenite has been recognized to be a reliable tool (Suzuki 1993), and widely used in age studies of various ore deposits (McCandless and Ruiz

1993; Santosh 1994). Re-Os dating was also used in investigation of the Ni-Mo-Pt bearing black rock series (Li 2003). In this study, the Re-Os isotopes of ore mineral molybdenite is analysed to determine the source rock for the copper mineralization in southern Gangdese block.

Molybdenite occurs mainly as disseminations and occasionally as lumps in the mineralized in both porphyritic granodiorite and granodioritic porphyry. A total of 9 molybdenite samples were collected from the Chongjiang, Tinggong and Dabu porphyry copper deposits. Re-Os dating measurements were conducted at the China National Research Center of Geoanalysis, by Wenjun Qu and Gang Yang in 2002. To separate Re and Os, aqua regia was used to digest the samples in a Carius tube, then Re was extracted with acetone, and Os was purified by distilling. The measurements were made with the VG PQ EXCELL ICP-MS mass spectrometer. The blank chemistry procedure was employed with assumptions of 0.02 ng common Re and 0.003 ng common Os. Detailed method description was given by Du (2001).

The results of the measurements are shown in **Table 1**. The numbers in brackets are the 2σ level uncertainties, where for Re and Os isotopes, it includes the demarcating errors of diluent, ICP-MS measurement errors and calibration errors of mass fractional distillation as well as the weighing errors of diluent and samples. The errors for model ages include not only the errors mentioned above, but also the 1.02% overall uncertainty. The model ages (t) are calculated with the following formula:

TABLE 1. Concentrations of Re and Os isotopes and model ages of molybdenites from southern Gangdese porphyry copper deposits

Sample No.	Mine	Sample Weight(g)	Re($\mu\text{g/g}$)	^{187}Re ($\mu\text{g/g}$)	^{187}Os (ng/g)	Model Age(Ma)
CJ-18	Chongjiang	0.00806	223.0(2.3)	140.2(1.4)	32.41(0.24)	13.88(0.21)
TG-a	Tinggong	0.00821	266.5(3.0)	167.5(1.9)	41.74(0.36)	14.96(0.25)
TG-b	Tinggong	0.00835	252.6(2.4)	158.8(1.5)	40.01(0.35)	15.13(0.24)
DB-a	Dabu	0.00707	466.6(5.2)	293.3(3.3)	69.10(0.52)	14.14(0.23)
DB-b	Dabu	0.00505	422.4(4.3)	265.5(2.7)	63.80(0.47)	14.42(0.23)
DB-c	Dabu	0.00450	424.7(4.4)	267.0(2.7)	63.45(0.49)	14.27(0.23)
DB-d	Dabu	0.00478	430.9(4.5)	270.8(2.8)	64.25(0.51)	14.24(0.23)
DB-e	Dabu	0.00957	252.6(2.5)	158.8(1.5)	37.60(0.32)	14.21(0.23)
DB-f	Dabu	0.00673	361.3(3.7)	227.1(2.3)	54.02(0.41)	14.28(0.23)

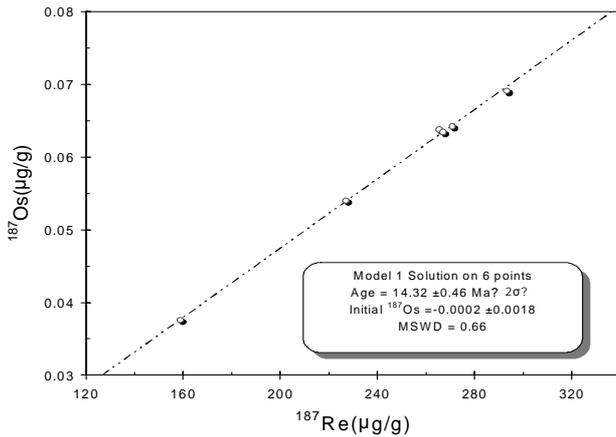


FIGURE 1. ¹⁸⁷Re-¹⁸⁷Os Isochron for the molybdenite from Dabu porphyry copper deposit

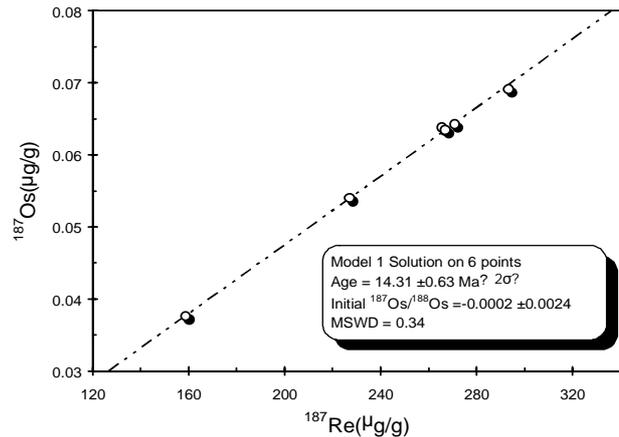


FIGURE 2. ¹⁸⁷Re-¹⁸⁷Os Isochron for molybdenite from Chongjiang, Tinggong and Dabu porphyry copper deposits

$$t = \frac{1}{\lambda} \left[\ln \left(1 + \frac{{}^{187}\text{Os}}{{}^{187}\text{Re}} \right) \right]$$

where, λ (¹⁸⁷Re decay constant) = $1.666 \times 10^{-11} \text{ yr}^{-1}$.

The Re-Os dating results demonstrate that the molybdenites of the three porphyry copper deposits have almost the same model age of 14Ma. The ¹⁸⁷Re-¹⁸⁷Os isochron diagrams of molybdenites from Dabu and all the three deposits, plotted with ISOPLOT software, indicate that their isochron ages are $14.32 \pm 0.46 \text{ Ma}$ for Dabu porphyry copper deposit (Figure 1, 1.5% and 1.0% are taken as the relative errors for ¹⁸⁷Re and ¹⁸⁷Os, respectively) and $14.0 \pm 1.0 \text{ Ma}$ for all the Chongjiang, Tinggong and Dabu porphyry copper deposits (Figure 2, 2.5% and 1.5% are taken as the relative errors for ¹⁸⁷Re and ¹⁸⁷Os, respectively). The points plotted from Chongjiang and Tinggong data are roughly on the isochron line defined by the 6 points plotted from Dabu data.

The Re-Os isotope data clearly indicate that tectonically porphyry copper mineralization in the central region of south Gangdese block occurred in the rifting-deduction environment after the closure of the Yarlung Zangbo Tethys and the consequent orogeny. The porphyry copper mineralization was

genetically related to the small-scaled post-collision granitoid rocks. In the Chongjiang, Tinggong and Dabu porphyry deposits, the copper mineralization is genetically related to the granodiorite porphyry dykes.

Acknowledgement

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