Research Advances

$^{40}$Ar/$^{39}$Ar Geochronology of Weathering Process in the Tu-Ha Basin, Northwest China

YANG Jing$^{1,2}$, CHEN Wen$^1$, ZHENG Dewen$^2$, YANG Li$^1$, ZHANG Yan$^1$ and LIU Xinyu$^1$

1 Institute of Geology, Chinese Academy of Geological Sciences, National Key Laboratory of Continental Structure and Dynamic, Laboratory of Isotope Thermochronology, Beijing 100037, China
2 State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration, Beijing 100029, China

The Asian interior contains the most regionally extensive areas of mid-latitude deserts and semi-deserts in the world, and its timing and forcing mechanisms of aridification has attracted much attention. The Tu-Ha Basin is one of the major hyperarid areas in the northwestern China; however, the initiation and history of aridification of this basin have been poorly understood. There are widely distributed deep weathering profiles and associated supergene oxidation zones through the Tu-Ha Basin, with commonly observed supergene K-bearing sulfate minerals, especially jarosite minerals. The formation and preservation of the jarosite minerals in the weathering profiles record an arid-semiarid climate and a transition toward hyperarid conditions. Therefore, $^{40}$Ar/$^{39}$Ar dating of supergene jarosite is a useful tool to infer the paleoclimatic conditions from the knowledge of "weathering timescales". Till now, our project has dated new $^{40}$Ar/$^{39}$Ar ages for supergene jarosite from three weathering profiles: the Hongshan deposit, the Liuhuangshan deposit, and the Caihuagou deposit, to precisely constrain the timing and duration weathering and supergene enrichment in the Tu-Ha Basin. These results are also used to provide new insights into the paleoclimatic conditions and the landscape evolution.

Eleven supergene samples collected from the three weathering profiles yielded well-defined ages ranging from 33.3±0.1 Ma to 33.4±0.4 Ma. Combined with the previously published K-Ar ages, these ages indicate a

Fig. 1. Digital map showing regional topography of the Tu-Ha Basin and the location of the three researched deposits (red symbols): the Hongshan deposit, the Liuhuangshan deposit, and the Caihuagou deposit.

* Corresponding author. E-mail: yangjing822822@gmail.com

© 2015 Geological Society of China
protracted history of weathering and supergene enrichment from the beginning of the Oligocene to the Middle Pliocene. The present geochronological data suggest that the weathering age of the three deposits is temporally consistent, though not identical, and that the evolution of weathering profiles is mainly dependent on regional climate. Therefore, these ages demonstrate that chemical weathering and supergene enrichment under an arid-semiarid climate have emerged at 33.3 Ma, 27.7–23.3 Ma, 16.4–14.7 Ma, and prevailed at 11–7.8 Ma. After 11–7.8 Ma, a progressive change from the arid-semiarid towards hyperarid climatic conditions, and predominantly hyperarid conditions may have persisted at least since 4.1–3.3 Ma. The paleoclimate inferred from the \(^{40}\)Ar/\(^{39}\)Ar geochronology is consistent with the chemical parameters and isotopic compositions of the Cenozoic sedimentary sequence from the Lianmuqin section in the Tu-Ha Basin. The age versus elevation obtained in this study confirms that the high elevation sites hosting the most complex and complete weathering profiles at present, also host the most comprehensive distribution of ages. The presence of ancient weathering ages in current outcrop of the Tu-Ha Basin suggests that denudation was not homogeneous, and that the landscape evolution follow a scarp retreat model.

**Acknowledgements**

This work is supported by National Science Foundation of China (Grant No. 41403047, 41272215 and 41473053).