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Editorial

Frontiers in geoscience: A tribute to Prof. Xuanxue Mo – Preface



1. Introduction

In response to the proposal by the Earth Science community of China, we are delighted to organize this special issue of *Geoscience Frontiers* (GSF) in honor of the work by Xuanxue Mo, Professor of Petrology and Geochemistry of China University of Geosciences (Beijing) and Academician of the Chinese Academy of Sciences, as a tribute to him on his 80th birthday. In his over 50 years of professional career, Prof. Mo has contributed enormously to the developments of China's Earth Sciences and it is fair to say that Prof. Mo is one of the most influential administrators, educators and researchers in China's Earth Science community and also internationally. The research papers assembled in this special issue reflect the authors' appreciation of Prof. Mo who has benefitted them as students, collaborators and colleagues over the years.

Below we provide a brief summary of the life and career of Prof. Mo in Geology, along with a selected bibliography of his influential papers, followed by a concise introduction to the papers of this special issue.

2. Tribute to Xuanxue Mo

Xuanxue Mo (Fig. 1), born on December, 21st, 1938 in Rongshui County, Guangxi Province, China, is a Professor at China University of Geosciences (Beijing), and was elected Academician of the Chinese Academy of Sciences in 2009. He studied in Nanjing School of Geology (now incorporated into Southeast University, China) in 1953–1956, and continued his study at Beijing College of Geology (now China University of Geosciences) in 1956–1960. Since his graduation in 1960, he has worked for Beijing College of Geology, Wuhan College of Geology, China University of Geosciences (Wuhan) and China University of Geosciences (Beijing) as teaching assistant, lecturer, associate professor and professor. From 1981 to 1983, he was a visiting scholar working with late Prof. Ian S. E. Carmichael at Department of Geology, University of California, Berkeley, USA. From 1993 to 2003, he served as the Dean of Graduate School of China University of Geosciences (Beijing and Wuhan) and Vice President of China University of Geosciences (Beijing).

During his over 50 years of career in research, teaching, and educational administration, Prof. Xuanxue Mo has made outstanding contributions in the fields of thermodynamics of

magmatism, crust-mantle deep processes, and tectonics-magmatism-metallogenesis.

He conducted innovative experimental petrology on thermodynamics of silicate melts and magmatism. In 1982, he published the experimental results of the partial molar volume of Fe_2O_3 and other major components in silicate melt accomplished at the Lawrence Berkeley National Laboratory, USA. It was the first time in the global literature to report the experimentally-determined partial molar volume of Fe_2O_3 and to create a predictive model on densities of Fe_2O_3 -containing multicomponent silicate melts, as well as the pressure dependence of oxygen fugacity and P - T - α_{SiO_2} - $f\text{O}_2$ diagrams for magmas of varying compositions. This work has been fundamental for understanding magma generation and evolution, and evolution of the Earth and planets. This achievement was highly appraised by two USA national reports and has been highly cited in *Nature*, *Geochimica et Cosmochimica Acta*, *Journal of Geophysical Research* and other leading Earth Science journals.

Prof. Mo has conducted a long-term systematic study on tectonic-magmatic processes of the Tibetan Plateau, using the innovative approach of "Lithoprobe". He developed (1) a new concept on the timing of the India-Asia continental collision, (2) a model of "Two types of crust and two modes of thickening mechanisms" for explaining the formation of the thickened crust of the Tibetan Plateau, and (3) a new view on deep crust and mantle flow beneath the Greater Tibetan Plateau.

Prof. Mo has long been committed to the research on the relationship between magmatism and mineralization in the broad Jinshajiang-Lancangjiang-Nujiang (abbr. Sanjiang) Tethyan metallogenic region, bringing forward the general theory of "Two ore-forming systems; Three major ore-controlling factors" and its specific prospecting targets. He made major contributions to the establishment of the Sanjiang national mineral resources research base in Southwest China, for which he received the 2005 "First-class Award of National Science and Technology Progress".

According to Web of Science and ResearchGate, Prof. Mo's 278 papers were cited 7475 times by SCI journals (among 9499 times of all citations). Also, he first-authored three scientific books. He has also supervised more than 60 students with 52 awarded PhD and 10 awarded MSc, and one of his outstanding students has been elected Academician.

Prof. Mo has been involved in many international activities during his scientific career. For instance, he was Vice Chairman of the Academic Committee of the 30th International Geological Congress in 1996, Vice Regional President of the Society of Economic

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Figure 1. Xuanxue Mo.

Geologists (SEG) for Asia, a Member of Disciplinary Evaluation Experts of the National Natural Science Foundation of China (1996–2006). He is now the Editor in Chief of *Acta Geologica Sinica* (Chinese Edition, 2013–2018) and of *Geoscience Frontiers* (2017 IF = 4.051) (2010–present).

Ten selected publications of Xuanxue Mo

Mo, X.X., Carmichael, I.S.E., Rivers, M.L., Stebbins, J., 1982. The partial molar volume of Fe_2O_3 in multicomponent silicate liquids and the pressure dependence of oxygen fugacity in magmas. *Mineralogical Magazine* 45, 237–245.

Mo, X.X., Hou, Z.Q., Niu, Y.L., Dong, G.C., Qu, X.M., Zhao, Z.D., Yang, Z.M., 2007. Mantle contributions to crustal thickening during continental collision: Evidence from Cenozoic igneous rocks in southern Tibet. *Lithos* 96 (1–2), 225–242.

Mo, X.X., Niu, Y.L., Dong, G.C., Zhao, Z.D., Ke, S., 2008. Contribution of syncollisional felsic magmatism to continental crust growth: A case study of the Paleogene Linzizong volcanic Succession in southern Tibet. *Chemical Geology* 250 (1–4), Pages 49–67.

Mo, X.X., Zhao, Z.D., Deng, J.F., Flower, M., Yu, X.H., Luo, Z.H., Li, Y.G., Zhou, S., Dong, G.C., Zhu, D.C., Wang, L.L., 2006. Petrology and geochemistry of postcollisional volcanic rocks from the Tibetan plateau: Implications for lithosphere heterogeneity and collision-induced asthenospheric mantle flow. *Geological Society of America Special Paper* 409, p. 507–530. [https://doi.org/10.1130/2006.2409\(24\)](https://doi.org/10.1130/2006.2409(24)).

Zhao, Z.D., Mo, X.X., Dilek, Y., Niu, Y.L., DePaolo, D.J., Robinson, P., Zhu, D.C., Sun, C.G., Dong, G.C., Zhou, S., Luo, Z.H., Hou, Z.Q., 2009. Geochemical and Sr-Nd-Pb-O isotopic compositions of the postcollisional ultra-potassic magmatism in SW Tibet: Petrogenesis and implications for India intra-continental subduction underneath southern Tibet. *Lithos* 113 (1–2), 190–212. <https://doi.org/10.1016/j.lithos.2009.02.004>.

Zhou, S., Mo, X.X., Dong, G.C., Zhao, Z.D., Qiu, R.Z., Guo, T.Y., Wang, L.L., 2004. ^{40}Ar - ^{39}Ar geochronology of Cenozoic Linzizong volcanic rocks from Linzhou Basin, Tibet, China, and their geological implications. *Chinese Science Bulletin* 49 (18), 1970–1979.

Mo, X.X., Zhao, Z.D., Deng, J.F., Dong, G.C., Zhou, S., Guo, T.Y., Zhang, S.Q., Wang, L.L., 2003. Response of volcanism to India-Asia collision. *Earth Science Frontiers* 10(3), 135–148 (in Chinese with English abstract).

Mo, X.X., Dong, G.C., Zhao, Z.D., Zhou, S., Wang, L.L., Qiu, R.Z., Zhang, F.Q., 2005. Temporal and spatial distribution and characteristics of the Gangdese granites and implications for the crustal growth and evolution. *Geological Journal of China Universities* 11(3), 281–290 (in Chinese with English abstract).

Mo, X.X., 2011. Magma and magmatic rocks: a lithoprobe into the deep Earth and records of the Earth's evolution. *Chinese Journal of Nature* 33(5), 255–259 (in Chinese with English abstract).

Mo Xuanxue (Ed.), 2009. *Cenozoic Collision-Postcollisional Igneous Rocks in the Tibetan Plateau*. Geological Publishing House, Beijing, 396 pp (in Chinese).

3. Special issue contents

In the opening paper of this special issue by [Niu \(2018\)](#) probe into the origin of large-low-shear-wave-velocity provinces (LLSVPs) at the base of the mantle. The author proposes a new hypothesis that involves irreversible subduction of the ocean crust of basaltic composition to the lower mantle and marks the LLSVPs as permanent graveyards. The LLSVPs are considered to act as thermal insulators, making core-heating induced mantle diapirs or plumes initiated at their edges. The LLSVPs are also considered stable in the spinning Earth.

[Yoshida and Santosh \(2018\)](#) present results from three-dimensional numerical simulations of mantle convection to address the voyage of the Indian subcontinent since the breakup of the supercontinent Pangea. They integrate results from numerical results of mantle convection from 200 Ma to the present, and from the present to the future, and propose that mantle drag force acting on the base of continents may be comparable to the slab pull force, suggesting that convection in the shallower part of the mantle is strongly coupled with surface plate motion.

[Hall et al. \(2018\)](#) employ apatite U–Pb thermochronology to the granitoid basement across the northern Gawler Craton to unravel the Proterozoic, post-orogenic, cooling history and to examine the role of major fault zones during cooling. They show that the results are consistent with the structural architecture of the Gawler Craton and reveal the thermal footprint of known tectonic and magmatic events in the Gawler Craton.

[Takahashi et al. \(2018\)](#) report petrological, phase equilibria modeling, and fluid inclusion data for pelitic and mafic granulites from Rundvågshetta in the highest-grade region of the Neoproterozoic Lützow-Holm Complex in East Antarctica with a view to trace the evidence for fluid-rock interaction and high-temperature metasomatism. They report primary brine-rich fluid inclusions and the occurrence of Cl-rich biotite suggesting that infiltration of brine fluid could have given rise to the high-temperature metasomatism.

[Kim et al. \(2018\)](#) evaluate the features of Permo-Triassic high-pressure (HP) metamorphism along the central western Korean Peninsula with a view to gain insights into the Late Permian to Triassic collisional orogeny in northeast Asia. They present P – T – t paths and together with the metamorphic ages and post-orogenic igneous events reported from these areas, subduction, accretion and exhumation history is traced, with tectonic linkage among the northeast Asian continents during the Paleo-Tethyan Ocean closure.

[Zhang et al. \(2018\)](#) investigate corundum-bearing rocks from the Gangdese magmatic arc in east-central Himalaya, remains unknown. Based on geochemical features and isotopic ages, the author infer contact metamorphism induced by the intrusion of gabbroic rocks. The metasomatic alteration probably occurred under P – T conditions of ~ 2.2 – 2.8 kbar and ~ 650 – 700 °C. These corundum-bearing rocks and their equivalents in Central and Southeast Asia are correlated to the Cenozoic Himalayan orogeny.

[Zheng et al. \(2018\)](#) report a new ophiolitic mélangé from Tepai in the northern Alxa region. From geochemical features, they identify boninite-like features and suggest that the rocks formed in a subduction-related environment, and were derived from an extremely depleted mantle source infiltrated by subduction-derived fluids and/or melts.

[Tang et al. \(2018\)](#) present results from petrology, geochemistry and isotope geochronology of ophiolites from the western part of the Bangong-Nujiang suture zone in northern Tibet. Their data suggest that the Zhongcang ophiolite was formed by the subduction of the Bangong-Nujiang Ocean during the Middle Jurassic. They also suggest that the final continental collision between the Lhasa and

Qiangtang terranes probably occurred later than the Early Cretaceous (ca. 110 Ma).

[Dong et al. \(2018\)](#) evaluate the petrogenesis and tectonic implication of early Paleozoic granitoids from the Kunlun Belt based on geochemical and isotopic data. Their results suggest that the diorite and granodiorite were derived from partial melting of heterogeneous crustal source with variable contributions from ancient continental crust and juvenile components, and that the monzogranites represent fractional crystallization and crustal contamination for arc magma. The magmas were emplaced in a continental marginal arc setting linked to the southwards subduction of the Paleo Kunlun Ocean.

[He et al. \(2018a\)](#) investigate the granitoids of Central Altai using zircon U–Pb and Hf isotopes. Their results suggest that the monzogranite was generated from the mixing of pelitic and mantle material whereas the granodiorites were formed by partial melting of juvenile lower crust. Integrated with results from previous studies, the authors suggest long-lived subduction and accretion along the Altai Orogen during ca. 425–294 Ma.

[Duan et al. \(2018\)](#) assess the discriminating features of ore-forming intrusions in a super-large porphyry Mo deposit in NE China. Their results suggest that the ore-forming intrusions had higher oxygen fugacity conditions than those of the pre-mineralization and post-mineralization rocks. They also propose that subduction-related setting, crust-mantle interaction, and the large-scale magmatic intrusion were favorable factors to generate the super-large Mo deposits.

[He et al. \(2018b\)](#) present molybdenite Re–Os and zircon U–Pb ages as well as geochemistry of the newly-discovered Donglufang Mo–Cu porphyry–skarn deposit in the southern Yidun Terrane of southeast Tibet. Their study reveals a temporal link between granitic magmatism and Mo–Cu mineralization. The authors propose a model of magma genesis from a thickened ancient lower crust in a post-collisional setting.

[Lee et al. \(2018\)](#) evaluate the structural styles of thrust development in the central Alberta Foothills of the Canadian Rockies. Their results suggest that factors such as stratigraphic thickness changes of incompetent layers and mechanical stratigraphy of the sedimentary layers play an important role in the development of lateral variations in thrust system evolution in terms of triangle zone vs. imbricate fan in the central Alberta Foothills.

In the final contribution, [Cao et al. \(2018\)](#) apply calcareous nanoplanktons to evaluate the paleoclimatic conditions during Paleocene–Eocene Thermal Maximum in the Tarim Basin in NW China. Their results suggest that the southwestern Tarim basin was a warm shallow continental shelf and from the early Eocene, the environment changed conspicuously to acidic, resulting in the disappearance of marine planktons.

We hope that the papers presented in this special issue provide a brief glimpse on some of the topics in geosciences that Prof. Xuanxue Mo promoted and actively involved in during his glorious career. We thank all the authors who contributed to this volume, and also the referees who spent their valuable time and efforts to provide timely reviews. We also thank Dr. Lily Wang and Dr. Fei Gao at *Geoscience Frontiers* editorial office in CUGB for their valuable support.

References

- Cao, W.X., Xi, D.P., Melinte-Dobrinescu, C., Jiang, T., Wise Jr., S.W., Wan, X.Q., 2018. Calcareous nannofossil changes linked to climate deterioration during the paleocene–eocene thermal Maximum in the Tarim basin, NW China. *Geoscience Frontiers* 9 (5), 1465–1478.
- Dong, G.C., Luo, M.F., Mo, X.X., Zhao, Z.D., Dong, L.Q., Yu, X.H., Wang, X., Li, X.W., Huang, X.F., Liu, Y.B., 2018. Petrogenesis and tectonic implications of early

- Paleozoic granitoids in East Kunlun Belt: evidences from geochronology, geochemistry and isotopes. *Geoscience Frontiers* 9 (5), 1383–1397.
- Duan, P.X., Liu, C., Mo, X.X., Deng, J.F., Qin, J.H., Zhang, Y., Tian, S.P., 2018. Discriminating characters of ore-forming intrusions in the super-large Chalukou porphyry Mo deposit, NE China. *Geoscience Frontiers* 9 (5), 1417–1431.
- Hall, J.M., Glorie, S., Reid, A., Boone, S.C., Collins, A.S., Gleadow, A., 2018. An apatite U–Pb thermal history map for the northern Gawler Craton, South Australia. *Geoscience Frontiers* 9 (5), 1293–1308.
- He, D.F., Dong, Y.P., Xu, X.Y., Chen, J.L., Liu, X.M., Li, W., Li, X.M., 2018a. Geochemistry, geochronology and Hf isotope of granitoids in the Chinese Altai: implications for paleozoic tectonic evolution of the central Asian orogenic Belt. *Geoscience Frontiers* 9 (5), 1399–1415.
- He, W.Y., Xie, S.X., Liu, X.D., Gao, X., Xing, Y.L., 2018b. Geochronology and geochemistry of the Donglufang porphyry–skarn Mo–Cu deposit in the southern Yidun Terrane and their geological significances. *Geoscience Frontiers* 9 (5), 1433–1450.
- Kim, H.S., Kwon, S., Kim, S.W., Santosh, M., 2018. Permo-Triassic high-pressure metamorphism in the central western Korean Peninsula, and its link to Paleo-Tethyan Ocean closure: key issues revisited. *Geoscience Frontiers* 9 (5), 1325–1335.
- Lee, H., Jang, Y., Kwon, S., Park, M.H., Mitra, G., 2018. The role of mechanical stratigraphy in the lateral variations of thrust development along the central Alberta Foothills, Canada. *Geoscience Frontiers* 9 (5), 1451–1464.
- Niu, Y.L., 2018. Origin of the LLSVPs at the base of the mantle is a consequence of plate tectonics – a petrological and geochemical perspective. *Geoscience Frontiers* 9 (5), 1265–1278.
- Takahashi, K., Tsunogae, T., Ugwuonah, E.N., 2018. Fluid-induced high-temperature metasomatism at Rundvågshetta in the Lützow-Holm Complex, East Antarctica: implications for the role of brine during granulite formation. *Geoscience Frontiers* 9 (5), 1309–1323.
- Tang, Y., Zhai, Q.G., Hu, P.Y., Xiao, X.C., Wang, H.T., 2018. Petrology, geochemistry and geochronology of the Zhongcang ophiolite, northern Tibet: implications for the evolution of the Bangong-Nujiang Ocean. *Geoscience Frontiers* 9 (5), 1369–1381.
- Yoshida, M., Santosh, M., 2018. Voyage of the Indian subcontinent since Pangea breakup and driving force of supercontinent cycles: insights on dynamics from numerical modeling. *Geoscience Frontiers* 9 (5), 1279–1292.
- Zhang, Z.M., Ding, H.X., Dong, X., Tian, Z.L., Mu, H.C., Li, M.M., Qin, S.K., Niu, Z.X., Zhang, N., 2018. The Eocene corundum-bearing rocks in the Gangdese arc, south Tibet: implications for tectonic evolution of the Himalayan orogen. *Geoscience Frontiers* 9 (5), 1337–1354.
- Zheng, R.G., Li, J.Y., Xiao, W.J., Wang, L.J., 2018. A new ophiolitic mélange containing boninitic blocks in Alxa region: implications for Permian subduction events in southern CAOB. *Geoscience Frontiers* 9 (5), 1355–1367.

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