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Geological, geochemical, and geochronological characteristics of Egyptian VMS prospects: A review for further exploration

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The Arabian–Nubian Shield (ANS) is the Earth's largest block of juvenile Neoproterozoic crust. Mineral resources are the foundation for the economic prosperity of developing countries in the ANS. The ANS contains numerous deposits with discoveries of more than 45 Moz Au and Au equivalent in the last two decades. Volcanogenic Massive Sulfide (VMS) deposits are one of the most important ore deposits in ANS. Egyptian VMS deposits are mainly distributed in central and southern parts of the Eastern Desert. Historically, the oxidized outcrops were used as prospective guides to discover these prospects. Ancient Pharaohs targeted the exposed mineralized zones but left the unexposed ores and alteration areas largely untouched. As a result of limited geological and prospecting studies that have been carried out, the researchers have not been entirely developed the geodynamic evolution and metallogenesis of these deposits. In this contribution, we are collected up-to-date published data, including field and petrographic studies, whole-rock geochemistry, mineral chemistry analyses, *in situ* U-Pb-Lu-Hf zircon dating, and sulfur isotopes data. The aims of the present study are to (a) characterize the Egyptian VMS occurrences, (b) promote a better understanding of dynamic processes, (c) develop a genetic model, (d) identify potentially fertile areas, and (d) pay attention to potential avenues for future development of the metal-mining sector. The resulting information is very homogeneous and indicates that all Egyptian VMS prospects have a spatial, temporal, and genetic connection with volcanism and were predominantly formed within extensional geodynamic regimes (back-arc basin setting) during the Mozambique Ocean closure stage of the Pan-African Orogeny. They share very similar characteristics including geological evolution (tholeiitic and calc-alkaline magmatism, arc-like geochemical signatures, positive εHf values, juvenile source), Neoproterozoic age (~695 Ma), host-rock succession, ore minerals and patterns (massive, disseminated, and vein-type sulfides), alteration intensity and mineralogy (sericitization, chloritization, epidotization, and silicification), physico-chemical conditions (low pressure, low oxygen fugacity, shallow depth, ~1200 °C), and syngenetic origin (positive $\delta^{34}S_{V\text{-}CDT}$ values). The polymetallic nature and mineralization styles make the studied prospects an attractive exploration target. Therefore, they present a key opportunity to modern-day explorers with much further geological and geophysical studies are required.