
Preface

This book is the first assembly of modern scientific papers on mineral deposits of North Africa. In total, 22 papers report new field and laboratory data on diverse types of metallic deposits in Morocco, Algeria, Tunisia, Mali, Mauritania, Egypt, Sudan, and Eritrea. Originally our goal was to include papers on deposits in Niger, Libya, and Chad, but political and other issues prevented this from being realized. Most of the deposits described herein are economically important—including several of world-class stature in terms of amount of contained metal, but others are relatively small or at present are only exploration prospects, yet are important in terms of regional metallogeny and potential future mining activity.

The lead paper, by M. Bouabdellah and J.F. Slack, provides a comprehensive overview of the geology and metallogeny of North Africa. This contribution synthesizes geological, geochemical, isotopic, and radiometric data bearing on the setting and origin of major deposits in the region, together with information on tonnages and grades, where available. All types of economically important metallic and non-metallic deposits are described, divided among the following categories: (1) orthomagmatic chromium-nickel-platinum group elements, (2) rare metal (tantalum, niobium, tin, rare-earth element [REE]) granites and related rare-metal pegmatites, (3) volcanic-hosted massive sulphide (VHMS) copper-zinc-gold-silver, (4) sedimentary-exhalative (SEDEX) zinc-lead-silver, (5) orogenic and intrusion-related gold, (6) iron oxide-copper-gold (IOCG), (7) banded iron formation (BIF), (8) Mississippi Valley-type (MVT) zinc-lead, (9) sediment-hosted stratiform copper, (10) sediment-hosted lead, uranium, manganese, and phosphate, (11) five-element veins containing nickel-cobalt-arsenic-silver-bismuth(-uranium), (12) epithermal gold-silver, (13) skarn and replacement tungsten, tin, and/or base-metals, (14) residual manganese, phosphate, salt, potash, bentonite, etc., and (15) mechanically concentrated deposits (e.g., paleoplacer gold).

Papers on specific deposits or districts are divided among commonly defined major types or classes of deposits. Within the category of porphyry, skarn, and epithermal deposits, the first paper by G. Levresse, M. Bouabdellah, A. Cheilietz, D. Gasquet, L. Maacha, J. Tritlla, D. Banks, and A. Samir describes the giant Imiter silver-mercury vein deposit and suggests that degassing was the main ore-forming process. The next contribution, by M. Rossi, L. Tarrieu, A. Cheilietz, D. Gasquet, E. Deloule, J.-L. Paquette, H. Bounajma, T. Mantoy, L. Ouazzani, and L. Ouchtouban, reports ages of

magmatic and hydrothermal events in the polymetallic tungsten-gold and lead-zinc-silver deposits of the Tighza district of Morocco, proposing links to granite-related porphyry and epithermal processes. M. Bouabdellah and G. Levresse follow with a description of the Bou Madine gold-silver-lead-zinc (\pm copper) deposit in a Neoproterozoic caldera setting, and summarize evidence for an epithermal origin. The next paper, by E. Pelleter, A. Cheilletz, D. Gasquet, A. Mouttaqi, M. Annich, Q. Camus, E. Deloule, L. Ouazzani, H. Bounajma, and L. Ouchtouban, reports new U/Pb ages of magmatism in the Zgounder epithermal silver-mercury deposit of Morocco, providing evidence for a genetic tie to Neoproterozoic felsic magmatism. The following contribution by C. Marignac, D.E. Aïssa, A. Cheilletz, and D. Gasquet describes the metallogenic evolution of tungsten skarn and polymetallic vein deposits of the Edough-Cap de Fer district of Algeria, including fluid inclusion data that support a model for tectonically controlled mineralization during the formation of a late Miocene metamorphic core complex. M. Bouabdellah, R. Jabrane, D. Margoum, and M. Sadequi conclude this part with a study of the skarn to porphyry–epithermal transition recorded in the Ouixane iron district of Morocco, using new geochronological and fluid inclusion data to suggest a genetic link to Neogene high-K calc-alkaline to shoshonitic magmatism.

Hydrothermal vein-type deposits are described in the next group of papers. The first, by M. Bouabdellah, L. Maacha, G. Levresse, and O. Saddiqi, summarizes information on the vein-type cobalt-nickel-iron-arsenic (\pm gold \pm silver) deposits of the famous Bou Azzer district in Morocco, and proposes a long-lived, magmatic-hydrothermal to low-sulphidation epithermal system of late Hercynian to Triassic age. The next paper, by C. Marignac, D.E. Aïssa, A. Cheilletz, and D. Gasquet, reports on copper-zinc-lead vein mineralization of the Aïn Barbar deposit in the Edough-Cap de Fer polymetallic district of Algeria, suggesting links to a late Miocene paleogeothermal system. Following is a contribution by M. Bouabdellah, L. Maacha, M. Jébrak, and M. Zouhair on Re/Os geochronological and isotopic (lead and sulphur) constraints on the origin of the Bouskour copper-lead-zinc vein-type deposit in Morocco and its relationship to Neoproterozoic granitic magmatism. The next paper by M. Bouabdellah and D. Margoum describes the Aouli sulphide \pm barite \pm REE-rich fluorite vein systems of the upper Moulouya district in Morocco, attributing this mineralization to Pangean rifting and opening of the Tethys and Central Atlantic oceans. The last paper in this group, by M. Bouabdellah, O. Zemri, M. Jébrak, A. Klügel, G. Levresse, L. Maacha, A. Gaouzi, and M. Souiah, reports on the geology and mineralogy of the El Hammam REE-rich fluorite deposit in Morocco, suggesting a link to transtensional Pangean and Central Atlantic rifting.

The next category comprises orogenic and granitoid-hosted gold and/or rare-metal deposits. In the first paper, D.M. Lawrence, J.S. Lambert-Smith, and P.J. Treloar review orogenic and reduced granitoid-hosted gold mineralization in Mali, and present fluid inclusion and stable isotope data for major deposits in districts such as Loulo-Gounkoto and Morila. This is followed by I.K. Khalil, A.M. Moghazi, and A.M. El Makky on mineralogical and geochemical constraints bearing on the origin and geodynamic setting of

Neoproterozoic vein-type gold mineralization in the Eastern Desert of Egypt. The following contribution, by C. Marignac, D.E. Aïssa, L. Bouabsa, M. Kesraoui, and S. Nedjari, describes the Hoggar gold and rare metals metallogenic province of the Pan-African Tuareg Shield in Algeria, proposing an early Cambrian rift-related origin for this mineralization. The final paper in this part is by M. Bouabdellah, F. Chekroun, A. Alansari, and D. Margoum, on the granitoid-related Tiout gold deposit in Morocco, including a model involving a polyphase, late magmatic to hydrothermal system of Neoproterozoic age.

Two papers are included in the category of VHMS deposits. The first, by C.T. Barrie, M. Abu Fatima, and R.D. Hamer, reports on VHMS and oxide gold mineralization in the Neoproterozoic Nubian Shield of Northeast Africa, with a focus on deposits in Eritrea, Sudan, and Egypt. The second paper is by M. Bouabdellah, M. Hibti, L. Maacha, M. Zouhair, and F. Velasco, who describe geologic, hydrothermal, and geochemical relationships between bimodal magmatism and massive sulphide mineralization in the Hercynian central Jebilet-Guemassa province of Morocco.

MVT and Sedex deposits are represented by two contributions. The first by M. Bouabdellah and D.F. Sangster reviews the geology, geochemistry, and current genetic models for major MVT lead-zinc deposits of Morocco, and based on orebody geometries and lead isotope constraints proposes a link to the closing stage of the Alpine orogeny. The second paper, by S. Decrée, C. Marignac, R. Abidi, N. Jemmali, E. Deloule, and F. Souissi, describes Sedex lead-zinc and polymetallic deposits in northern Tunisia and draws comparisons and contrasts with MVT deposits in the region.

The last part is focused on sediment-hosted iron and manganese deposits. The first contribution, by C.D. Taylor, C.A. Finn, E.D. Anderson, D.C. Bradley, M.Y. Joud, M.A. Taleb, and J.D. Horton, summarizes information on the giant Mesoarchean and Paleoproterozoic BIF deposits of the F'derik-Zouérate iron district in Mauritania, and presents the results of new airborne geophysical surveys and detrital zircon geochronology. The last paper by A. Dekoninck, R. Leprêtre, O. Saddiqi, J. Barbarand, and J. Yans describes the giant, high-grade, karst-hosted Imini manganese deposit in Morocco, and proposes a model in which Mn precipitation occurred with increasing pH and Eh, linked to dolomite dissolution and the influx of oxygenated meteoric waters.

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