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Mineral Resources for the Future

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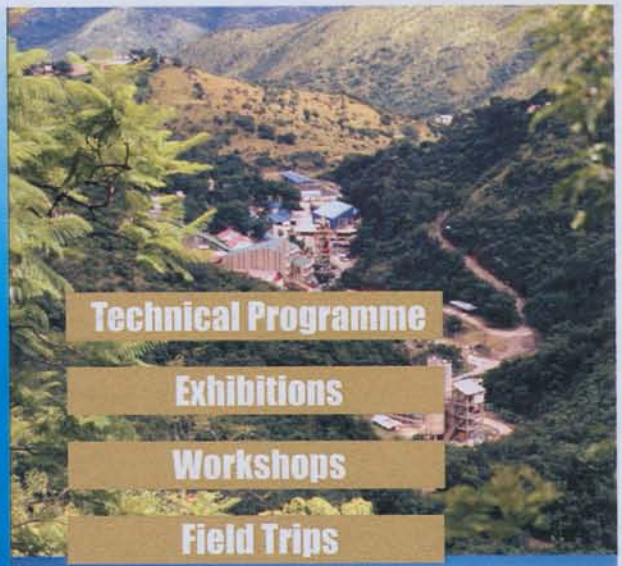

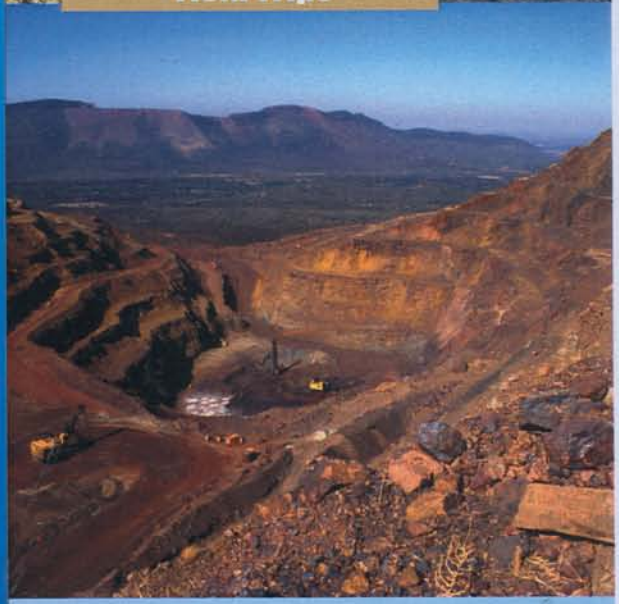

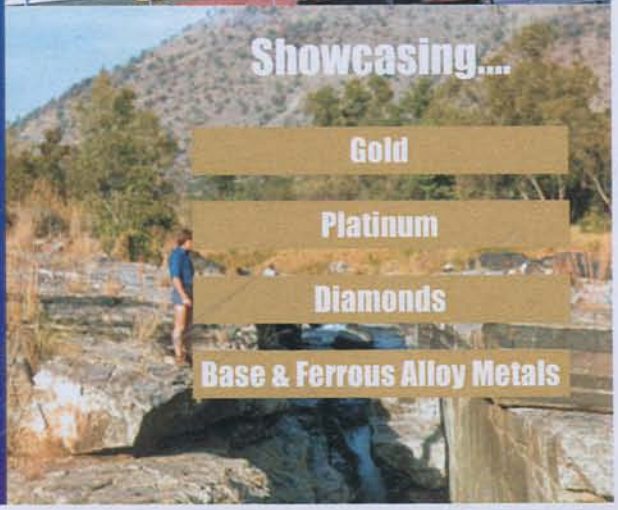

POSTER PRESENTATIONS

#	Title	Author
1	Mineralogical and petrographic signature of nonsulfide Zn ores as a key for recovery: The example of Accha (Peru)	Boni M *et al*
2	Genesis of the Lufilian foreland sandstone-hosted stratiform Cu mineralization, DRC: evidence from Lufukwe and Mwitapile	Hamdy El Desouky & Philippe Muchez
3	Evidence for two main Cu-Co phases in the Katanga Copperbelt, DRC	Hamdy El Desouky *et al*
4	The Mafuga Gold Prospect, Uganda: Extension of the Kivu Gold Belt	Craig McClung & Thanusah Naidoo
5	Magambazi Gold: A potentially new orogenic gold deposit style in the Handeni District of Tanzania	D I Groves *et al*
6	Metal resources and potential in NE Mozambique	Sandstad J S *et al*
7	The mineralization process as deduced from Sr isotopic data from Lonplats' Eastern Platinum Mine, Western Bushveld Complex and large-scale geometry of the floor of the Merensky Reef	Refilwe Shelembe
8	Chromite mining in Madagascar: geological and mineralogical constraints affecting product quality	Anna Merlini *et al*
9	Relationships between metamorphism, magmatism and Au mineralization at Morila, Mali	Christopher RM McFarlane *et al*
10	Geology of the Ndepa Inlier and the surrounding Karoo Sequences – Implications on the tectonic-evolution of the Mid-Zambezi Basin	David Katemaunzanga *et al*
11	Coal quality prediction and market adaptability at Hwange Colliery Company Limited in Zimbabwe – Low phosphorus challenge	David Katemaunzanga *et al*
12	Multiple sulphur isotope analysis of detrital pyrite in Archaean sedimentary rocks: a tool for provenance analysis of Witwatersrand-type placer gold deposits	Axel Hofmann *et al*
13	Dos Lagunas Au-Ag epitermal vein system of Los Menucos District, Northpatagonic Massif, Patagonia Argentina	P Moreira *et al*
14	Jurassic silica sinters associated with La Josefina epithermal gold-silver deposits, Deseado Massif, Argentina. Should we "expect" fossil plants in Mesozoic sinters?	P Moreira *et al*
15	Alluvial and eluvial platinum-group minerals (PGM), Bushveld Complex, South Africa	Thomas Oberthür *et al*

Hamdy El Desouky *et al*

Evaluation of the Abu Kharif tungsten ore deposit, North Eastern Desert, Egypt, based on integration of field work, remote sensing and geochemistry

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1. Introduction

Twelve tungsten, tin-tungsten and tin mineral occurrences are scattered in the Eastern Desert of Egypt and hosted in its basement rocks (Takla et al., 1976; Fig. 1). They were mined for the production of wolframite, scheelite and cassiterite, during the Second World War. The mining activity ceased short at the end of the war without any record about the ore grades, distribution or controls. Recently, these occurrences received new attention due to the interest in a possible reopening of the old mines. The Abu Kharif Mountain, one of these twelve occurrences, is located at ~410 km southeast Cairo (Fig. 1). This occurrence was first discovered in 1934 and was partly mined by the British-Egyptian Mining Corporation. The aim of this research is to map and evaluate the economic importance of the mineralization at the Abu Kharif Mountain.

2. Geology and Mineralization

According to Abdel-Maksoud et al. (1978), the Abu Kharif area is covered by four rock units. The oldest unit consists of metavolcanics, which has a mafic to felsic composition. The younger three rock units are all granitic in composition. They are termed older, younger and alkali granite. Those authors also explained that all rock units, except the alkali granite, are crosscut by series of mafic to felsic dykes and faults.

Field work confirms that the closed tungsten mine is located in the southwestern part of the mountain and hosted in the younger granite unit of Abdel-Maksoud et al. (1978). The mineralization is concentrated in two zones with ~1.5-2 km length, 0.3-0.5 km width and ~0.5 km away from each others. Each zone is composed of a series of discontinuous, steeply dipping (20-50 degrees to the N and NW), often thin (cm- to meters-thick) wolframite-bearing quartz veins. The veins are NE-SW and E-W oriented with few N-S oriented ones. The veins, which always are associated to shearing and fracturing, have no sharp contacts with the host granite; there is always a transition zone with severe wall-rock alterations. This zone is composed of mixed greisenized granite and quartz and possibly subdivided to three sub-zones: one adjacent to the quartz veins with much quartz and little greisenized granite, one adjacent to the host granite with much greisenized granite and little quartz and a middle zone with an intermediate composition. In the quartz veins, wolframite occurs as coarse-grained

crystals, which are disseminated and often aggregated in nests with ~30 cm diameter. The majority of these nests were mined from the outcropping quartz veins.

3. Remote Sensing

ASTER and Landsat satellite images were used to map the area of the Abu Kharif Mountain (El Desouky, 2005). Visual interpretations of true and false color composites (Sabins, 1999) allowed the discrimination between five rock units in addition to dykes and faults. Comparing this information to the information available from Abdel-Maksoud et al. (1978) and field work indicate that these rock units are the metavolcanics and four granitic rock units. One of these granitic rock units resembles the older granite of Abdel-Maksoud et al. (1978), two rock unites resemble the younger granite rock unit and the last one resembles the alkali granite rock unit. Interpretations of color composites of band ratios and principal component analysis (PCA) allowed the discrimination between the felsic and mafic metavolcanics and dykes. They also allowed the detection of the two mineralization zones due to their associated hydrothermally altered rocks. The two zones are hosted in only one rock unit of the two younger granite units. It was also clear from these composites that the faults and dykes, which thought to predate the alkali granite (Abdel-Maksoud et al., 1978) are postdating it. Based on this information supervised classifications were performed on the ASTER and Landsat bands, band ratios and principal components. The results of these classifications and the visual interpretations were integrated in a new geological map for the area of Abu Kharif. An ore deposit map comprising the two mineralization zones was constructed based on field work and unpublished field sketches.

Lineaments, which are most likely faults, fractures or dykes in the study area, were digitally extracted from ASTER band-2. A frequency rose diagram for the extracted lineaments indicates the presence of two major and two minor lineament directions at Abu Kharif. These directions are NE-SW, E-W, N-S and NW-SE respectively, i.e. similar to the quartz veins directions in the two mineralized zones. Three lineament density maps were constructed based on the total number and total length of lineaments per unit area and based on the number of lineament intersections per unit area. Interpretation of the lineament map and the lineament density maps in comparison with color composites showing the two mineralized zones indicates that the two zones are located in areas with high lineament density and at the intersection of two perpendicular major lineaments, which are most likely faults with NE-SW and NW-SE orientation.

4. Geochemistry

ICP-MS analysis on 22 samples from different quartz veins, alterations zones and granitic rock units indicates that the only possible economic metal is tungsten and its concentration is very heterogeneous inside the veins and sharply decreasing from the quartz veins towards the host granite. In the quartz veins, the tungsten has an average concentration of ~10700 ppm (~1.1 wt% W; n = 2) in the wolframite nests and only ~64.8 ppm (n = 3) away from these nests. The alteration zones show a tungsten concentration between 10.8 ppm and 20.7 ppm (average = ~15.1 ppm; n = 3) with a gradual decrease towards the host granite. In the granitic rocks, the tungsten concentration is often very low, it has a minimum of 2.1 ppm in the alkali granite and a maximum of 10.4 ppm in the older granite with an average value of 4.7 ppm (n = 14).

5. Discussion and Conclusions

The results of this research allowed for a better understanding of the geology of the Abu Kharif Mountain and clarified the limited economic importance of the former tungsten mine. The limited geometry of the ore zones, the variable and often thin thickness of the quartz veins, the steep dipping angles and discontinuity of the quartz veins and the low and very heterogeneous tungsten grades in the veins restrict the economic importance of the mineralization. The high tungsten prices and demands during the Second World War caused an active mining in this sub-economic mineralization, especially on the highest grade parts of the veins, i.e. the wolframite nests. By the end of the war these conditions changed, therefore the mining terminated.

The shearing which is often associated to the quartz veins, the similarity in the quartz veins orientation to the regional lineament (fault/fracture) directions and the presence of the two mineralization zones in areas with high lineament density and at the intersection of two perpendicular major faults, indicate a structural control on the tungsten mineralization at Abu Kharif. This suggests that an emplacement of the quartz veins took place simultaneous with the tectonic events responsible for the major faults in the area. Therefore the severe wall rock alterations around the veins are likely related to metasomatic processes associated with the vein emplacement hydrothermal activity.

6. Acknowledgments

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7. References

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8. Figure Captions

Fig. 1: Map showing the distribution of the twelve tungsten, tin-tungsten and tin mineral occurrences in the basement rocks of the Egyptian Eastern Desert (modified from Takla et al., 1976).

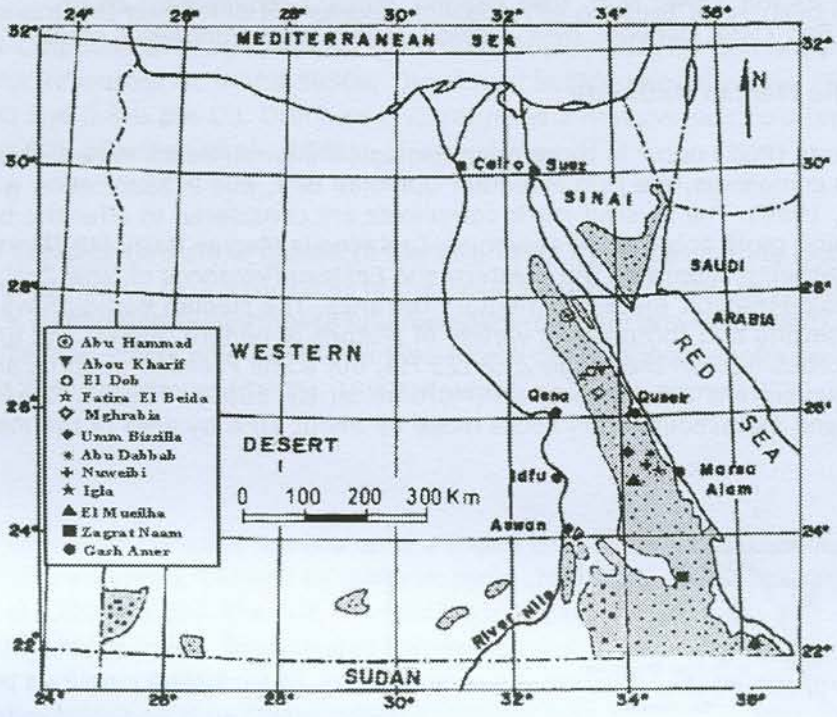

Figure 1