University of Glasgow

ISAAC
Imaging Spectroscopy And Analysis Centre

Process Optimisation in the Mining Industry

Marropino Mine, Mozambique

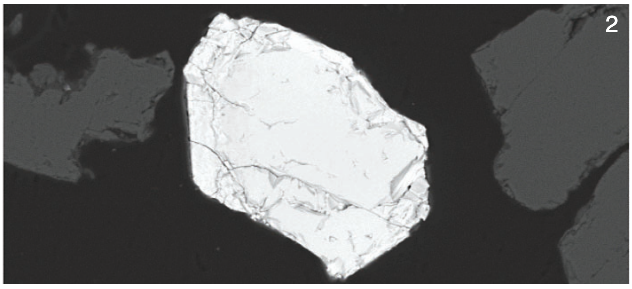
Tantalum – A Valuable Mineral Resource

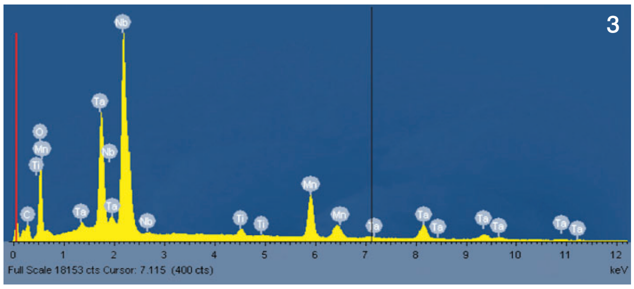
The very valuable element tantalum is in high demand because of its widespread use as a critical component in manufacturing electrolytic capacitors for mobile phones, computers, medical implants, and automotive electronics. Its worldwide requirement currently outstrips supply. Noventa, a Jersey based company, is a key supplier of tantalum from its Marropino mining concession in Mozambique.

Multi-Disciplinary Response to a Difficult Customer Challenge

Historically, Marropino's tantalum recovery was relatively poor. Typically less than 50% of tantalum contained in the mine's ores was recovered, with the remainder either left in waste dumps or lost during processing. As a result, the University of Glasgow was commissioned to undertake a project to assist Noventa to improve its tantalum recovery from the Marropino mine. The project involved the Hunterian Museum along with the Schools of Geographical and Earth Sciences (GES), Chemistry, and Physics and Astronomy (P&A). Crucial metrology and analytical support was provided by the Imaging Spectroscopy and Analysis Centre (ISAAC) in GES, Kelvin Nanocharacterisation Centre (KNC) in P&A, and X-ray diffraction facilities in Chemistry. This multi-disciplinary collaboration allowed the University of Glasgow to offer a broad spectrum of 'in-house' specialist expertise and analysis to address synergistically Noventa's difficult challenge.

The University's remit was to examine distribution and textural relationships of tantalum-rich mineral grains in the ores and to suggest ways in which processing efficiency might be improved. The results could have significant impact on the future economic viability of Marropino. Noventa was concerned that tantalum-bearing ores at Marropino were locked within grains of minerals that were problematic to process, such as mica, and thus could not be extracted. Another suspicion was that there might be significant tantalum in ultra-fine grains, which would be difficult or impossible to separate, despite the ores' apparent richness.



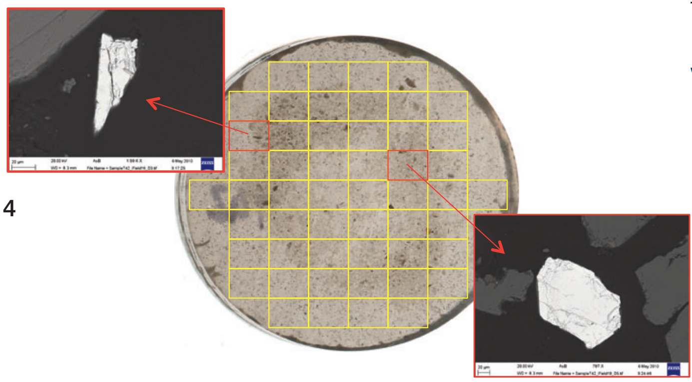


Bundle of Complementary Metrology Techniques Enable Broad Analysis

The University of Glasgow used a combination of techniques, including Chemistry's X-ray diffraction (XRD) to identify mineral phases, ISAAC's scanning electron microscopy (SEM) and KNC's focused ion beam (FIB) milling and transmission electron microscopy (TEM) to characterise the textural and structural features of minerals that might impact their behaviour during processing, and a Frantz isodynamic separator for magnetic separation. These bundled, complementary techniques, backed by the University's analytical and interpretative expertise, enabled the project to be delivered successfully.

ISAAC's field-emission analytical SEM was a key instrument for this project, as its capability for very high resolution examination of polished samples of GES-prepared ores provided valuable data. Several sophisticated SEM techniques were employed, including backscattered electron (BSE) imaging to determine the average atomic number of mineral grains, energy-dispersive X-ray analysis (EDX) to distinguish the chemical elements in very small samples, EDX element mapping to show the distribution of particular elements in discrete sample areas, and automated feature mapping to automatically scan, photograph, and analyse whole samples for tantalum grains.

KNC's FIB milling and TEM, used in combination, complemented ISAAC's SEM work by providing sample characterisation of crystal structure and chemical composition to an atomic scale.



The University's Expertise Supports Customer Process Improvements

After completing mineralogical, textural, and particle size analyses, the University of Glasgow was able to propose some simple and relatively inexpensive adjustments to existing processing technologies that could have a major impact in improving tantalum recovery. Milling ores to a slightly finer fraction size (< 1mm) demonstrated that significantly higher levels of tantalum-bearing grains could be liberated for processing. Mica crystals did not include many tantalum-rich grains, so mica could be removed early in the process for better efficiency.
In addition, very little tantalum occurred in the ores as ultra-fine grains, so their loss would not impact the mining operation's profitability. Finally, it was recognised that waste dumps from earlier mining still contained substantial tantalum quantities that could be economically recovered.

Noventa acknowledged the impact the University of Glasgow had in improving the performance of its mining operations at Marropino and subsequently engaged in further field study projects with geology students from Glasgow and universities in Mozambique.

ISAAC Contacts

School of Geographical & Earth Sciences

Gregory Building, Lilybank Gardens,
University of Glasgow, Glasgow G12 8QQ, UK

Peter Chung, Microanalyst

email: peter.chung@glasgow.ac.uk
Tel: 0141 330 5466 office / 5055 facility

www.glasgow.ac.uk/isaac

Images

1. *Marropino Mine.*
2-3. *ISAAC SEM automated mapping was used to scan large samples for tantalum-rich mineral grains (white particles), which were then examined at high resolution, and EDX easily identified the key chemical elements of tantalum (Ta) and niobium (Nb).*
4. *Ore sample with search area grid superimposed.*