

# GEOLOGY



The South Gobi area lies near the boundary of the South Mongolian and the South Gobi tectonic units. Primarily Paleozoic volcanic, sedimentary and intrusive rocks and Mesozoic sedimentary cover underlie the region. During the Paleozoic, southern Mongolia grew through the accretion of Island Arc- and Andean-type subduction, related magmatic arcs and continental blocks. Late in the Paleozoic, Basin and Range style rifting accompanied bimodal volcanism. By early Mesozoic, continental uplift was in progress, unroofing the tectonic belts with deposition of terrigenous sediments into thrust-controlled, foreland basins. At the end of the Late Cretaceous, the region was increasingly arid, similar to the present day Central Asian basins.

The Oyu Tolgoi project area occurs in an early to mid Palaeozoic island arc. The island arc exhibits characteristics typical for calc-alkaline, 'island arc-type' copper-gold (Cu-Au) porphyry deposits. The terrane is composed of lower to mid Paleozoic metasediments and island arc basalts that rest upon a lower Palaeozoic ophiolite complex.

## **Oyu Tolgoi Property Geology**

The Oyu Tolgoi property comprises a rectangular block 10 x 9 kms in area, in which exploration prospects are named South Oyu, Southwest Oyu, Central Oyu and Hugo Dummett (North and South). In general, outcrops are sparse and comprise less than 20% of the area. A Neogene piedmont outwash deposit forms a flat terrace dipping gently to the south, and occupies a NNW

trending zone in the center of the exploration block. This deposit comprises red clay and gravel and is up to 40m thick. Two major SSE drainages incise this terrace and are filled by Quaternary sands and gravels.

A tentative hardrock stratigraphy is based mainly on drilling data, and is described below from youngest to oldest:

1. Dacite flow units
2. Basaltic tuff and flow units
3. Upper Sedimentary sequence
4. Lower Sedimentary sequence
5. Dacitic pyroclastic units
6. Augite Basalt flow and related breccias
7. Andesitic volcanoclastic units

A wide variety of felsic to mafic dykes are found throughout the exploration block and in drill holes. Post mineral dykes comprise basalt, rhyolite, hornblende-biotite andesite, and biotite granodiorite intrusive units. The property also contains variably altered and mineralized porphyritic quartz monzodiorite dykes that may be genetically related to the Cu-Au porphyry systems.

Major structures trend N35E and N70E based on satellite imagery and geophysical interpretations. In addition, recent work in the sedimentary covered northern part of the property (Hugo Dummett region) has confirmed the occurrence of folded stratigraphy. Ongoing studies are attempting to unravel the attitude and extent of the folding event.

## **Mineralization and Alteration**

Mineralization and alteration at Oyu Tolgoi is characterized by multiple Cu-Au porphyry centres which occur (dependent on erosion of high sulphidation systems) above and partially telescoped onto the underlying Cu-Au porphyry systems.

The high-grade core of the Southwest Oyu deposit is a cylindrical shaped Cu-Au porphyry, 250 m in diameter, that extends vertically for over 800m. Mineralization is centered on small 10-30 m wide quartz monzodiorite (QMD) dykes and extends for over 100 m into the adjacent host basaltic volcanics. Contorted milky white quartz veins are developed in both the mineralized QMD and basaltic volcanics. The quartz veins appear to have formed largely as an early, relatively high temperature event. Chalcopyrite with subordinate pyrite and bornite occur as disseminated and late fracture fillings within the quartz veins and host rocks. Au to Cu ratios increase from 2:1 to 3:1 at depth. Alteration within the QMD is predominantly quartz sericite with minor tourmaline and fluorite. The basaltic volcanics feature biotite-magnetite with late chlorite-sericite.

Lower grade, propylitic altered basalt with 1:1 Au to Cu ratios extends for 600 m x 2000 m around the high-grade core. The QMD dyke bounding Southwest Oyu to the southeast is sericite altered at upper elevations and weakly mineralized with disseminated pyrite and chalcopyrite.

This style of mineralization is distinct from the porphyry style mineralization of Southwest Oyu and may represent the root zone to high sulphidation (HS) alteration systems, eroded away at South and Southwest Oyu, but still existent at the Central Oyu and Hugo Dummett deposits.

High sulphidation systems (HS) partly telescoped onto underlying porphyry systems occur at Central and Hugo, the latter hosted by dacitic ashflow tuffs which overly basaltic volcanics. At Central Oyu covellite-pyrite is related to an upwardly flared zone of intense quartz-sericite alteration and centred on porphyry-style quartz-veined Qmd dykes. In Central Oyu, a supergene-enriched chalcocite blanket, tens of metres in thickness has developed overlying the covellite, pyrite-rich HS mineralization. Sooty chalcocite coating pyrite and filling fractures underlies a 20 m to 60 m thick, hematite, goethite-rich leached cap.

High grade Cu mineralization at Hugo Dummett occurs predominantly as bornite, chalcocite and chalcopyrite. Pyrite, enargite, tetrahedrite-tennantite occur in subordinate amounts mainly in the Hugo Dummett South deposit. Sulphide associations correlate to the nature of alteration, which in turn is partly dependent on the host rock, but also exhibit a lateral zonation from the core of the high-grade shell ellipse. A typical sulphide zonation from the high-grade Cu core to low grade Cu mineralization is, bornite + chalcocite, followed outward to chalcopyrite (+/- tetrahedrite-tennantite) and then finally pyrite (+/- enargite). Enargite, bornite + pyrite, and locally covellite are common sulphide minerals in the ash flow tuff. A large part of the Hugo Dummett South deposit is hosted by ash flow tuff; while in contrast, the high-grade mineralization at Hugo Dummett North is almost entirely within basalt. Bornite+chalcocite-chalcopyrite with minor, enargite, tetrahedrite-tennantite occur in the basalt and Qmd intrusions. Molybdenite occurs locally in all rock types. Au (ppm): Cu (%) ratio's over much of the deposit are 1:10, but in strongly quartz-veined Qmd intrusions and adjacent wall rocks encountered in Hugo Dummett North, Au:Cu ratio's increase to 1:1. These high Au ratio's correlate with bornite.

## **Quality Assurance and Quality Control**

The QA/QC program used at the Oyu Tolgoi Project was developed by an independent quality control consultant and adopted in April 2002. Oyu Tolgoi LLC's sampling procedure comprises collection of core samples taken on continuous two-metre intervals down each drill hole, excluding dykes that extend more than 10 metres along the core length. Samples of one-half of NQ and HQ core, or one-quarter of PQ core, are taken for assaying. The core is marked with a continuous linear cutting line before being split to prevent a sampling bias. Splitting is done with a rock saw flushed continually with fresh water. Samples are placed in cloth bags and sent to an on-site preparation facility operated by SGS Mongolia LLC. In-house, matrix-matched Cu-Au-molybdenum standards and blanks are inserted at the sample preparation lab at the project site for quality-control monitoring of the assay data. All samples are assayed for Au, Cu, molybdenum, arsenic and silver.

Upon receipt of assay results, values for Standard Reference Material samples and field blanks are tabulated and compared to those from an established round-robin program. Assay results that deviate from round-robin program results beyond pre-set tolerance limits are rejected and subject

to re-assay. Oyu Tolgoi also performs check assays on a regular basis at the rate of one per batch of 20 samples.

Detailed analyses of the mineral reserves and resources for the Oyu Tolgoi Deposits have been prepared in conformance with the requirements set out in National Instrument 43-101 under the direction of various qualified persons as defined by NI 43-101. Please refer to estimate for details on the parameters used to calculate the estimate and the qualified persons responsible for preparing the estimate.