Geophysics of the Elang Cu-Au porphyry deposit, Indonesia, and comparison with other Cu-Au porphyry systems

T. Hoschke
Newmont Asia Pacific
388 Hay Street, Subiaco,
Western Australia
Terry.hoschke@newmont.com

SUMMARY

Elang is a large porphyry Cu-Au deposit situated about 70 km east of Batu Hijau on Sumbawa Island, Indonesia. The deposit is associated with a series of tonalite porphyry intrusions that are hosted by andesitic volcanics. Mineralisation is associated with potassic alteration (chlorite-magnetite±biotite) that produces a discrete magnetic high of about 700 nT. Forward and inverse modelling have been used to define this zone and the results have been used to direct drilling.

Very strong chargeabilities are associated with the porphyry alteration and resistivity from pole-dipole IP and airborne EM shows the extent of the alteration system. The Elang alteration system clearly shows up as a conductive zone in a relatively resistive background. There is an advanced argillic lithocap, up to 200 m thick, covering much of the deposit and is highly resistive and well defined with resistivity.

Elang is typical of a number of Cu-Au porphyry systems in that magnetite is associated with mineralisation and produces a strong discrete magnetic anomaly. It has a larger potassic zone than most systems, which may be due to more than one porphyry centre. The Elang system is more pyrite rich than many, leading to very strong chargeabilities, both in the ore zone and the pyrite halo. There is a broad resistive low due to clay alteration and sulphide veining similar to some other porphyry systems

Key words: Elang, Porphyry, Sumbawa

INTRODUCTION

The Elang porphyry Cu-Au deposit is located in south western Sumbawa in Indonesia approximately 60 km due east of the Batu Hijau Porphyry Cu-Au mine (Figure 1). It is a large deposit with a current resource estimate of 1430 Mt at 0.35 g/t Au and 0.33 g/t Cu (Ball, 2011).

A regional stream sediment sampling and mapping program in 1987 and 1988 led to the discovery of epithermal veins in the Elang area. After a small drilling program, where no

Figure 1. Location of Elang on SW Sumbawa

significant gold was detected, exploration ceased until after the discovery of Batu Hijau in 1991. The area was then reassessed for porphyry Cu potential and a large low grade resource was discovered. This was not considered economic at the time. Another phase of exploration began in 2002 and significantly added to the resource to the south under a lithocap of up to 200 m thickness.

The deposit is associated with a series of tonalite porphyry intrusions that are hosted by andesitic volcanics (Maula & Levet, 1996). The geology and alteration are shown in Figures 2a and 2b, respectively. Mineralisation is associated with potassic alteration (chlorite-magnetite±biotite) which grades outward to propylitic alteration. This system is overprinted by intermediate argillic alteration. There is an advanced argillic lithocap, up to 200 m thick, covering much of the deposit.

The Elang area was covered by an airborne magnetic survey in 1993 and the deposit was covered with ground magnetics soon after this. Gradient array IP/resistivity surveys were also conducted at this time.

Pole-dipole IP/resistivity surveys were conducted from 2003 to 2005, and HoisTEM and NewTEM were flown in 2004.

MAGNETIC RESPONSE

A helicopter magnetic and radiometric survey flown by Newmont in 1993 covered a large part of SW Sumbawa, including the Batu Hijau and Elang areas. The survey was flown in an east west direction with 200 m spacing between flight lines.

Elang shows up as a discrete magnetic high of about 700 nT within a relatively quiet area. The high is due to magnetite associated with the potassic alteration zone, which contrasts with a broader zone of magnetite destructive clay alteration. An attempt to invert this data failed to yield meaningful results, probably due to the coarseness of the grid. More success came from forward modelling the line data. Topography clearly affected the magnetic response and was taken into account in the modelling. Modelvision was used to model several lines concurrently and the best fit required two magnetic bodies with their outlines shown in Figure 2c. The low between the two magnetic bodies is probably due to a more weakly magnetic late tonalite intrusion (the Echo Tonalite).The larger southern body lies under the lithocap with a depth to top of up to 200m depending on topography. This model was used to help direct drilling during the 2002 to 2005 exploration program.

The ground magnetics are noisy but inversion results are surprisingly good and compare well with the forward modelling. The potassic zone as determined by drilling corresponds well with the zones of high magnetic susceptibility from the inversion model.

Magnetic susceptibility measurements on drill core confirm that the mineralised potassic zone is moderately to highly magnetic.

ELECTRICAL RESPONSE

IP surveys

Gradient array IP/resistivity surveys were conducted over Elang with a line spacing of 200 m and an electrode spacing of 50 m. There are strong chargeabilities associated with the Elang alteration system and a corresponding resistivity low. The lithocap was not detected in this survey.

Pole-dipole IP surveys conducted between 2003 and 2005 covered the deposit and surrounding alteration system. The line spacing was 100 m or 200 m with a potential electrode spacing of 50 m reading to N=10. A 3D inversion was applied to the lines covering Elang.

Very strong chargeabilities are associated with the porphyry alteration (Figure 2d). The limit of disseminated pyrite (sulphide shells of Lowell and Guilbert, 1970) is well defined, and drilling confirms a strong chargeability high on the eastern side of the survey is due to the pyrite shell of the porphyry system. A chargeability low immediately to the east of the deposit relates to a late dacite intrusion. Some of the more subtle lows may be due to late intrusive phases that are less mineralised.

The resistivity data clearly shows the extent of the alteration system with the porphyry alteration being relatively conductive at 10s of ohm-meters in a background of fresh volcanics in the 100s of ohm-meters. The highly resistive lithocap of 1000s of ohm-meters is well defined and the conductive zones are due to clay alteration and/or sulphide veining. Chalcopyrite veining in the potassic zone appears to be extensive and is probably a good conductor. This zone is generally too deep to be seen with the pole-dipole resistivity.

Airborne Electromagnetics

HoisTEM and NewTEM surveys were flown over Elang in 2004 and show similar results.

The Elang alteration system clearly shows up as a NE trending conductive zone in relatively resistive volcanics. The leached cap is highly resistive and is clearly identified by the HoisTEM. There are other conductors in the area that may represent alteration zones and there is a conductive sedimentary unit on the western side of the area. No other highly resistive zones, that might represent leached caps to other porphyry systems, were observed.

CONCLUSION

Elang is typical of a number of Cu-Au porphyry systems in that magnetite is associated with mineralisation and produces a strong discrete magnetic anomaly. It has a larger potassic zone than most systems, which may be due to more than one porphyry centre. The Elang system is more pyrite rich than many porphyries, leading to very strong chargeabilities both in the ore zone and the pyrite halo. There is a broad resistive low due to clay alteration and sulphide veining which is not uncommon in porphyry systems.

REFERENCES

Ball, R., 2011. Newmont Mining Corporation Presentation, CIBC Annual Instutional Investor Conference, Whistler, B.C.

Lowell, J. D. and Guilbert, J.M., 1970. Lateral and vertical alteration-mineralization zoning in porphyry ore deposits, Economic Geology 65: 373-408.

Maula, S. and Levet, B.K., 1996. Porphyry Copper-Gold Signatures and the Discovery of the Batu Hijau Deposit, Sumbawa, Indonesia, in Australian Mineral Foundation, eds., Conference on Porphyry Related Copper and Gold Deposits of the Asia Pacific Region: Cairns, Australasian, August 12-13, 1996, Proceeding, p.8.1-8.13.

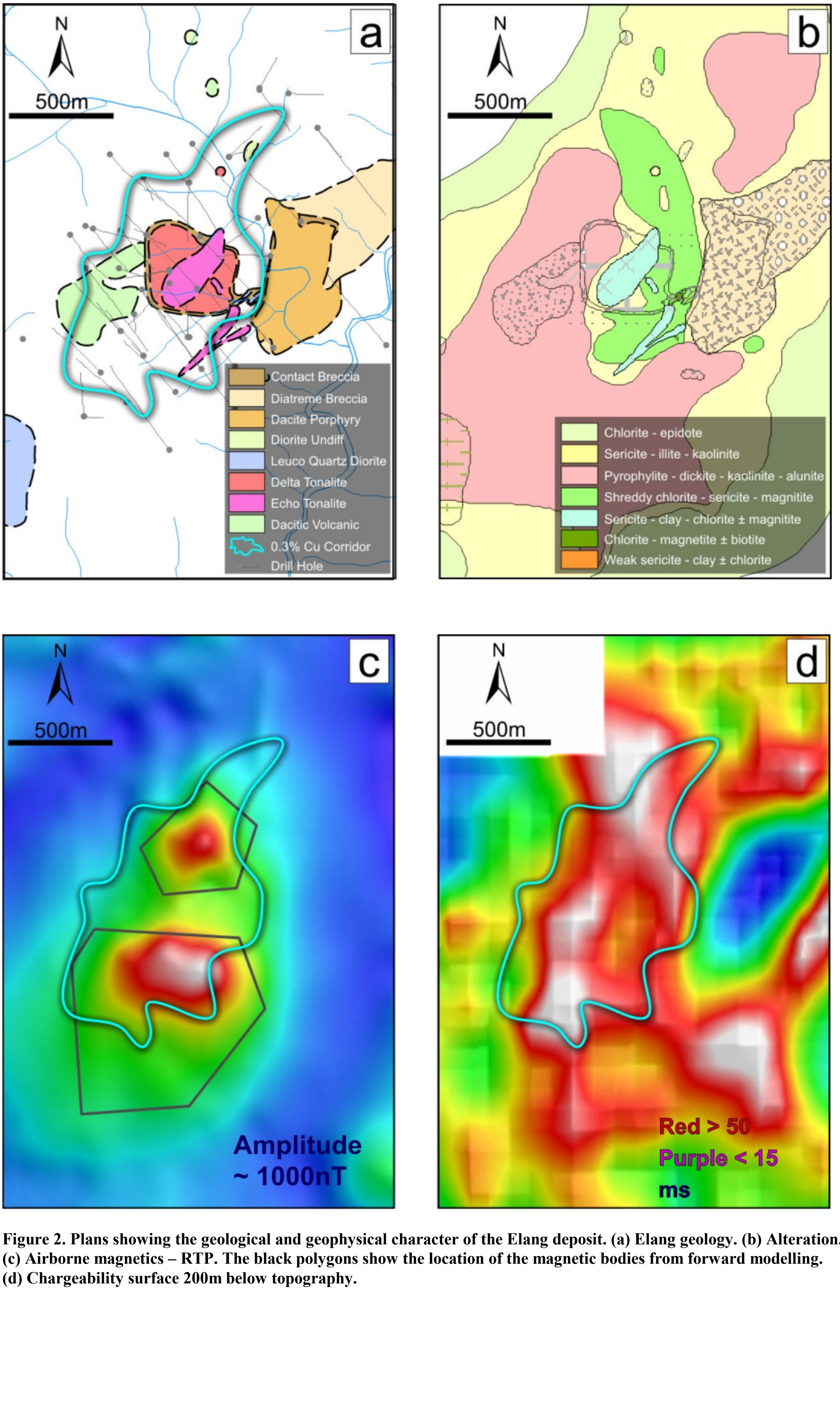

Figure 2. Plans showing the geological and geophysical character of the Elang deposit. (a) Elang geology. (b) Alteration. (c) Airborne magnetics – RTP. The black polygons show the location of the magnetic bodies from forward modelling. (d) Chargeability surface 200m below topography.