

## **Stockwork Vein Density Related to Hydrothermal Alteration and Ore Shell in the Bottom of the Grasberg Porphyry Cu-Au Open Pit Deposit**

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The Grasberg porphyry copper-gold deposit, the world's richest, is hosted within the Grasberg Igneous Complex (GIC). GIC consists of three main phases of igneous activity, the Dalam Igneous Complex, the main Grasberg Intrusion, and the Kali Intrusion. The Dalam and main Grasberg intrusion stages were between approximately  $3.33 \pm 0.12$  and  $3.19 \pm 0.05$  Ma, the Kali stage, between approximately  $3.16 \pm 0.06$  and  $3.06 \pm 0.03$  Ma, and Grasberg mineralization stage, between  $3.06 \pm 0.03$  and  $3.01 \pm 0.06$  Ma. The GIC crosscuts the axis of a large fold and was emplaced between left lateral strike-slip fault that trends subparallel to the regional structural grain created by the folded strata. The Grasberg Cu-Au orebody contains about  $2 \times 10^9$  at 1 wt % Cu and 1 g/t Au.

Stockworks (anhydrite-quartz veins) are predominant in the bottom of the open pit (3250-3415 level). The anhydrite veins are late stage and were cut by a quartz vein. Mostly anhydrite-quartz veins are part of potassic and phyllic zone. Stockwork vein systems form in the central high-temperature, potassic altered zones and are the locus of the highest Cu and Au grades in the porphyry orebody. Stockwork veins typically contain more than 1.2% copper-equivalent. The veins contain more than 10~15% pyrite, chalcopyrite, bornite, and covelite.

The assemblages exposed at level 3250-3415 are dominated by potassic-phyllic alteration. They follow the typical patterns of a potassic core grading outward into phyllic alteration, and surrounded by a propylitic halo at the shallower levels of the system. Advanced argillic alteration is weakly represented in the igneous rocks in the deepest parts of the pit. High Au/Cu ratios ( $>1$  g/t:%) are characteristic of ores formed within these central, high-grade zones.