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Fracture Density and Damage Zone Thickness Associated with Faults at the Resolution Copper Porphyry Deposit

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Faults are heterogeneous and anisotropic structures that generally consist of A) a fault core where most displacement is accommodated; B) one or more principal slip surface(s) within the fault core; and C) a surrounding fracture zone, which develops during displacement. Fracture density and damage zone thickness is variable and is at least partially controlled by host-rock lithology and depth (Hara et al., 2017). Fracture density is anomalously high in fault and damage zones and decays as a function of distance from the fault core to background levels (Faulkner et al., 2011) (Fig. 1A, B).

Fracture density and damage zones associated with faulting in unaltered sedimentary rocks is fairly well understood (e.g., Choi et al., 2015; Shipton et al., 2006), but is poorly studied in faults associated with metallic ore deposits. Here, we characterize over 600 fault and damage zones from drill core at the Resolution Copper Porphyry Deposit to better understand the primary controls on fracture density and damage zone thickness.

Fracture zones were identified by enhanced fracture density relative to background fracturing and may correspond to acoustic differences or mineralogical changes (Fig. 1C, D). Fracture zone boundaries were defined as the intersection point between two different gradients of cumulative fracture counts (Fig. 1B). The true stratigraphic thickness of damage zones was calculated from the average orientation of fault breccias within the damage zone.

References:

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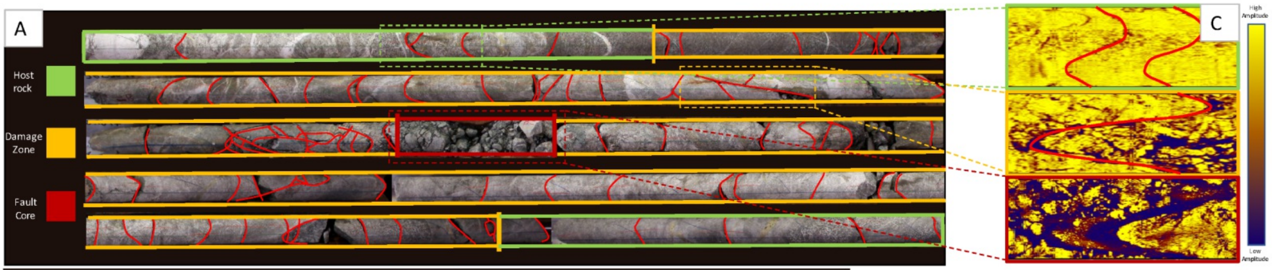

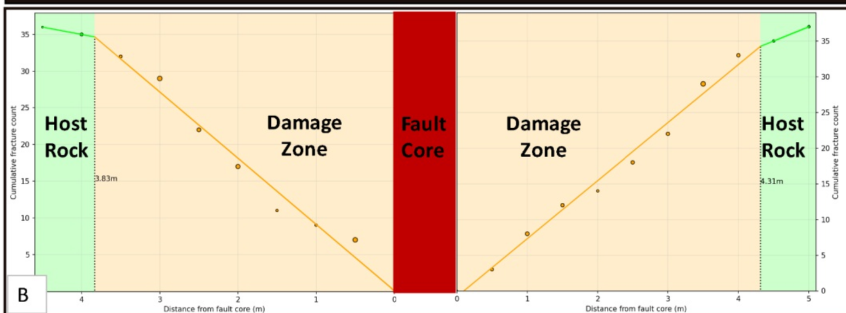

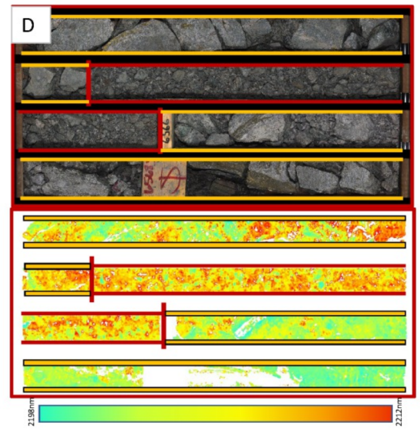

Figure 1. An example of the methodology and datasets used in this study to characterize fault and damage zones. A) Fault zone consisting of highly fractured damage zone and a brecciated fault core with 1-5cm diabase clasts in a fault gouge matrix. The host rock is locally foliated diabase with potassic (biotite and rutile after pyroxene and amphibole) and phyllic (white mica and kaolinite after plagioclase; quartz-sericite-pyrite±chlorite veins) alteration. Fractures are outlined in red. B) Bivariate plot of cumulative fracture counts against distance from the fault core. The damage zone boundary is defined by the intersection point between the two slope gradients. C) Acoustic borehole image of the undamaged host rock, damage zone, and the fault core. D) Half core from the fault in A with hyperspectral imagery from CoreScan showing the wavelength position of the 2200nm absorption feature. Higher wavelengths in the fault core suggest more Fe^{+2} and Mg^{+2} substituting in the octahedral site within micas.