Modelling Cu-Ni-PGE Vein Arrays Within an Offset Dyke Environment of the Sudbury Igneous Complex

The Universal Distinct Element Code (UDEC) is a two-dimensional numerical program based on the distinct element method for discontinuum modeling. UDEC simulates the response of discontinuous media (such as a fractured rock mass) subjected to either static or dynamic loading.

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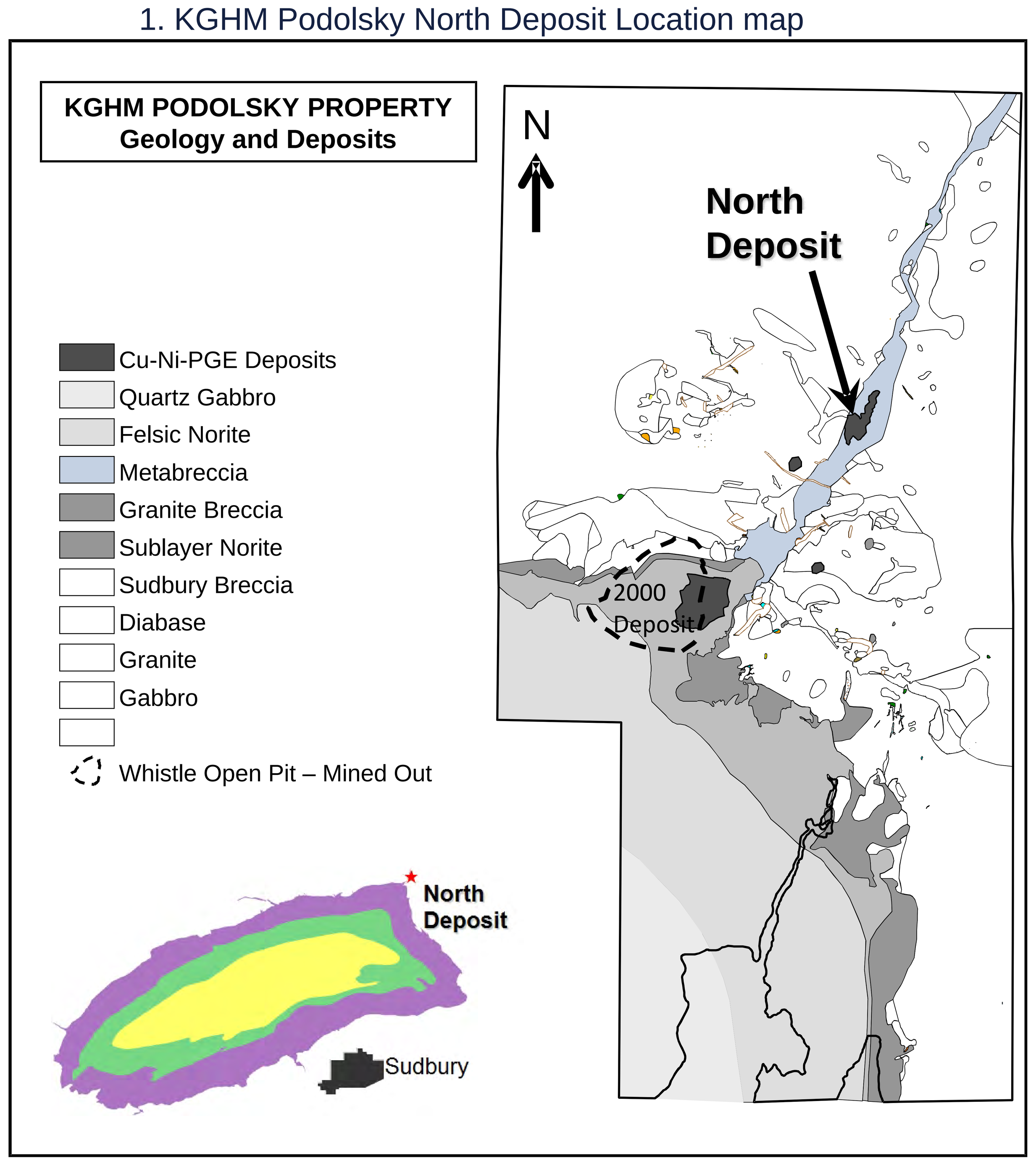
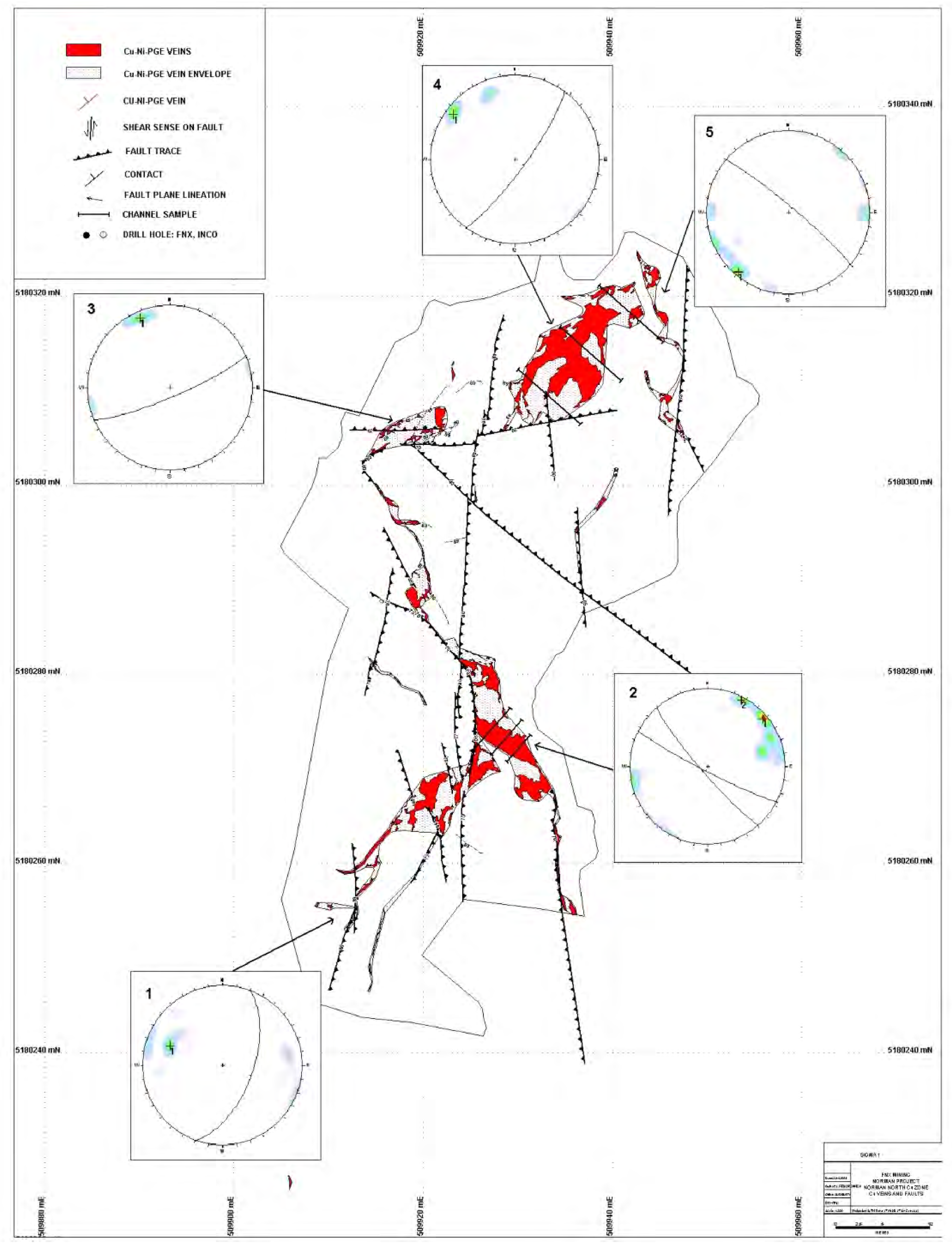
1. KGHM Podolsky North Deposit Location map



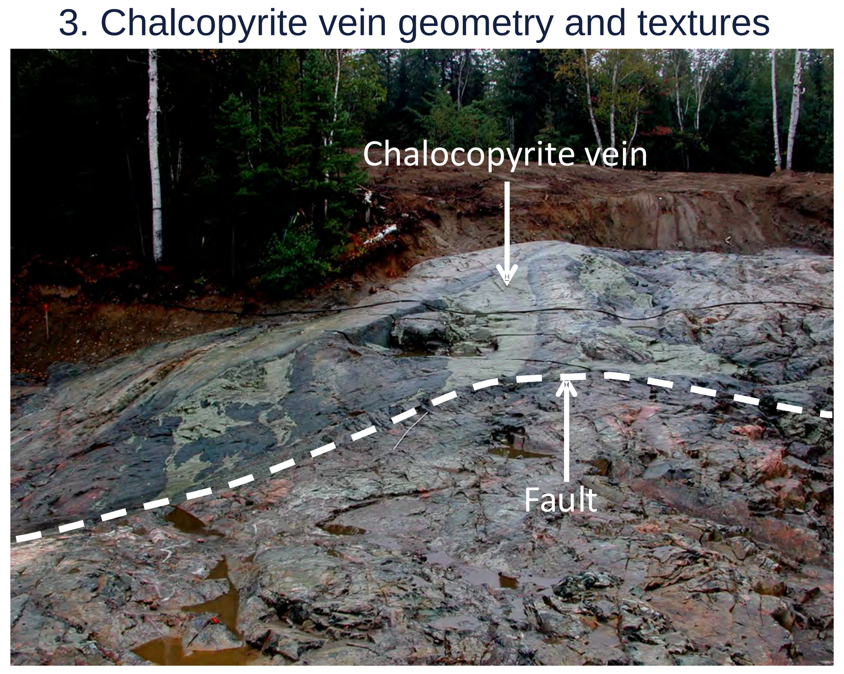
Podolsky North Deposit is located within the Whistle Offset dyke,in the northeast corner of the Sudbury Structure. The vertical dyke protrudes into basement gneisses in a NE direction from the Sudbury Igneous Complex. Dominant rock types in the Offset are Metabreccia (MTBX) and Inclusion Quartz Diorite (IQD).

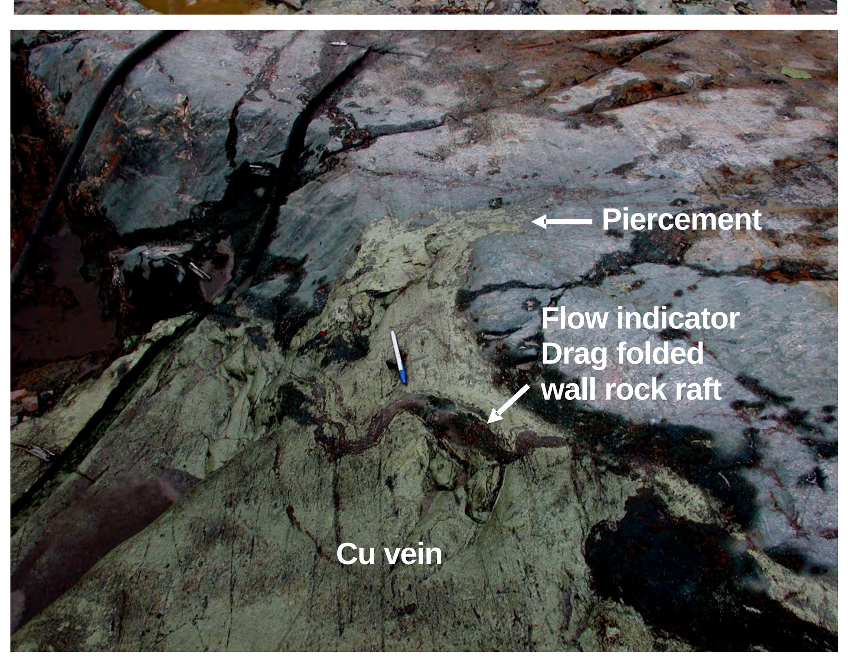
2. North Deposit Chalcopyrite Vein and Fault map



At North Deposit clusters of chalcopyrite-pyrrhotite-pentlandite veins (red) occur near the centre of the dyke. En echelon sets of 5-20cm thick faults (black lines) cross cut the host rocks, and segments of these faults appear to bound and control the chalcopyrite vein network. Lower hemisphere stereonet plots illustrate the dominant orientations of individually measured veins for each envelope.

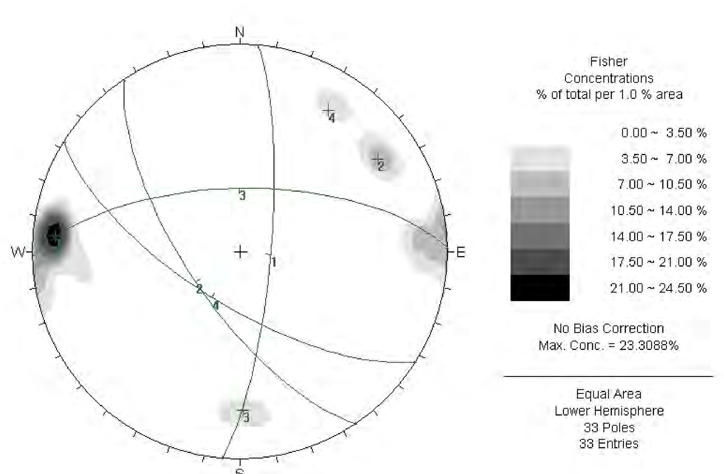
3. Chalcopyrite vein geometry and textures



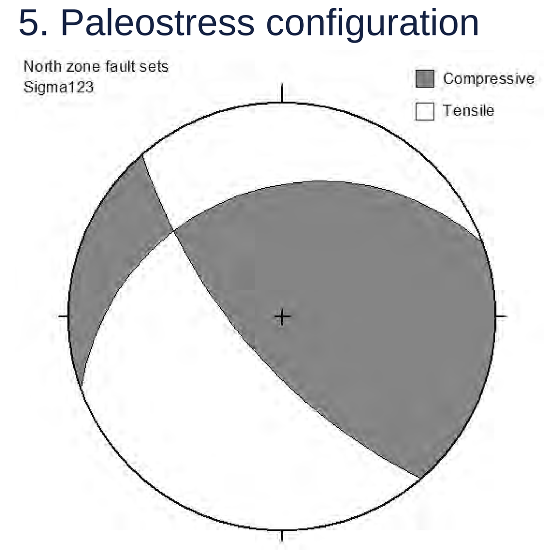


Top photo shows an array of chalcopyrite veins adjacent to a fault. Bottom photo illustrates the hangingwall contact of the vein and rucking of a wallrock raft concomitant with chalcopyrite vein emplacement.Significant chlorite-amphibole alteration forms a tight halo to the vein array.

4. Dominant fault orientations

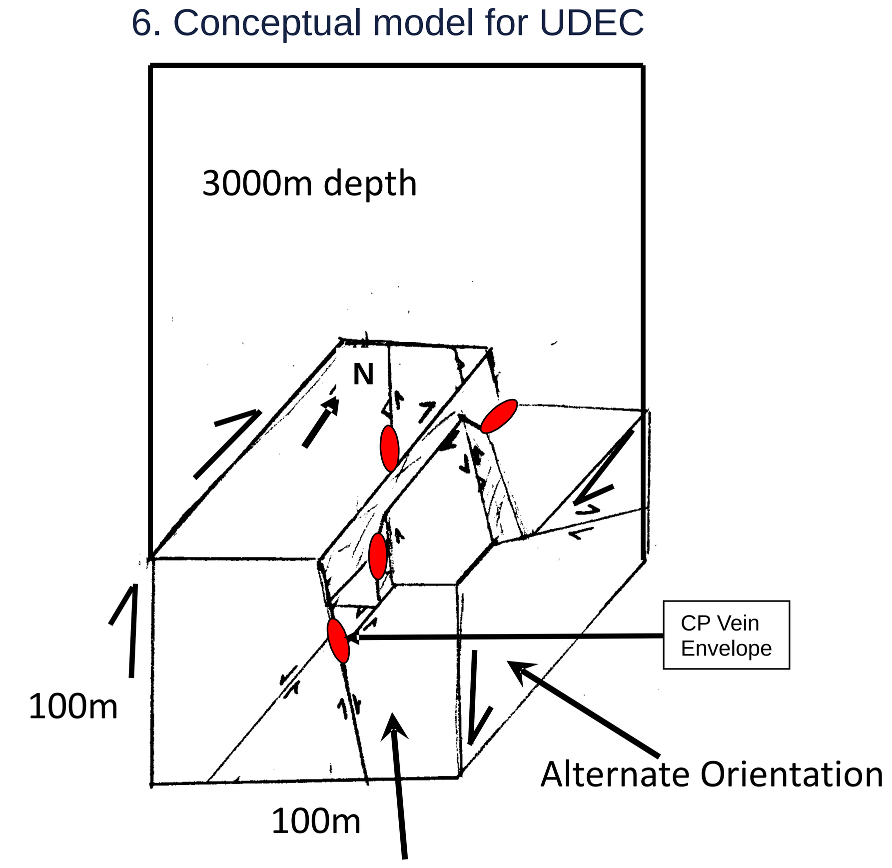


5. Paleostress configuration



Left figure is a lower hemisphere contoured stereonet plot for the 33 measure faults. They occur as four dominant sets each of which is >6% of the total population.
Right figure is a P-T diagram illustrating the palestress configuration determined from the shear sense of the fault sets and their dominant fault plane lineation orientations. Dark areas are compressive and white are tensile

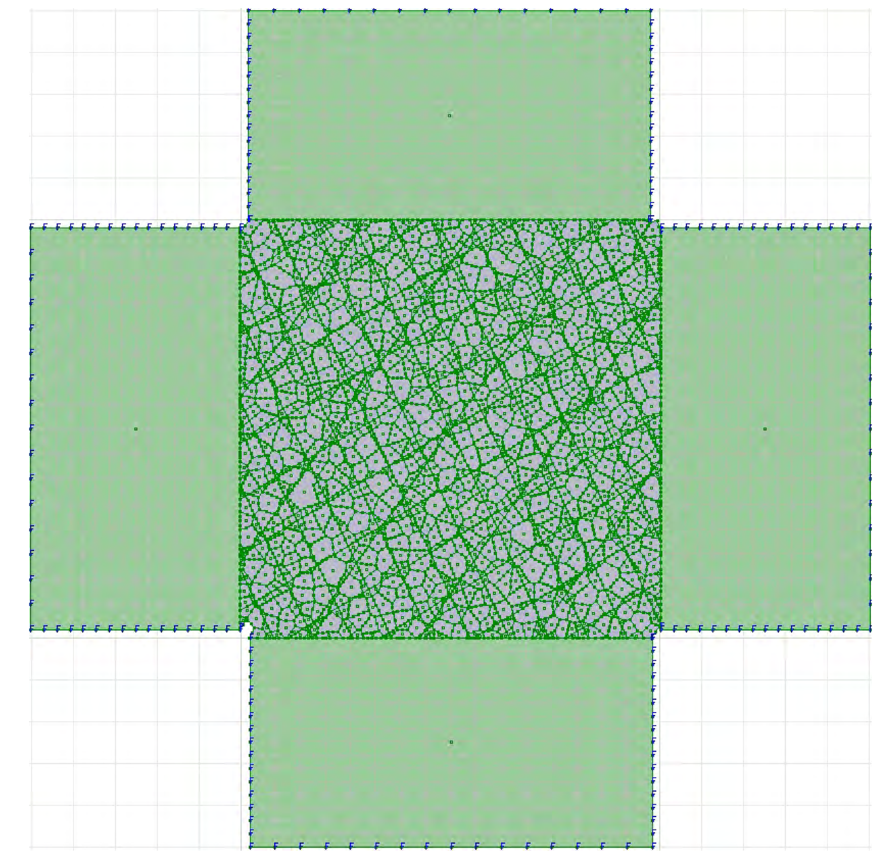
6. Conceptual model for UDEC



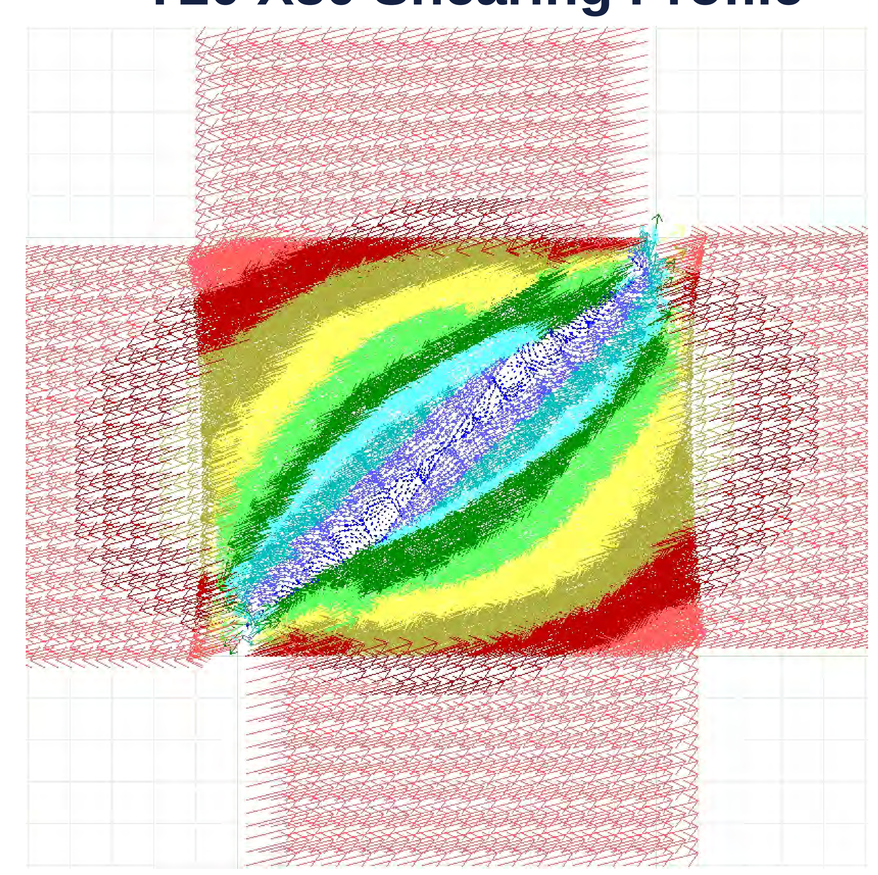
The conceptual model has vein openings formed by small incremental strike slip and dip slip fault movements within the Offset Dyke, and the openings are subsequently filled by Cu-rich fluid. The Universal Distinct Element Code (UDEC) is a two dimensional numerical modelling program based on the distinct element method for discontinuum modelling. In the current test two orientations were selected 1) a base orientation perpendicular to the Offset Dyke, and 2) an alternate orientation parallel to the dyke. The dominant fault sets were introduced as discontinuities, in their apparent dip for both orientations. Model runs were made for varying dip slip and strike slip components (e.g. 20% dip slip-80% strike slip, 30% dip slip 70% strike slip, and so on, for each orientation. Tesselation produced joints of random orientation between the main fault sets.

UDEC Base Orientation

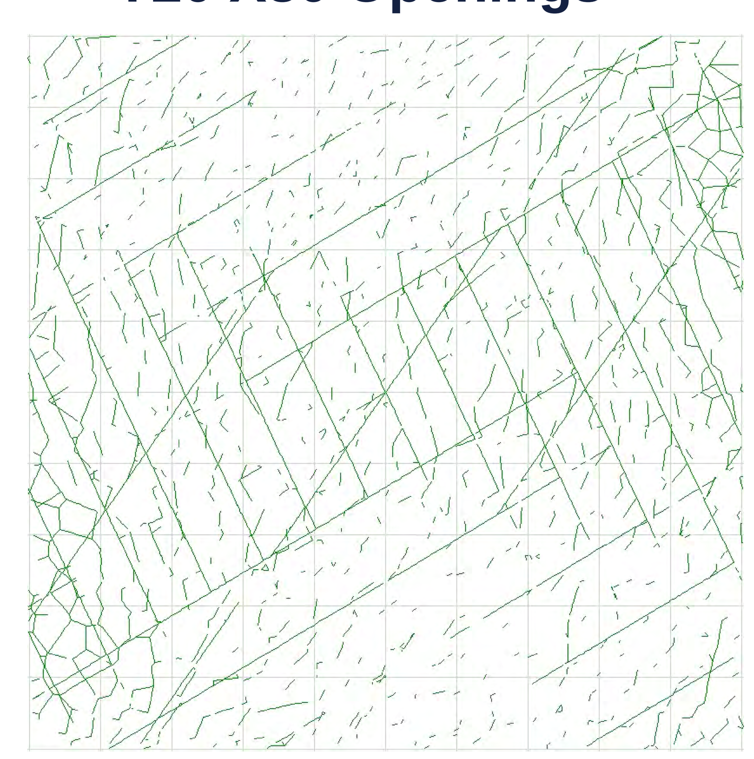
Unsheared model

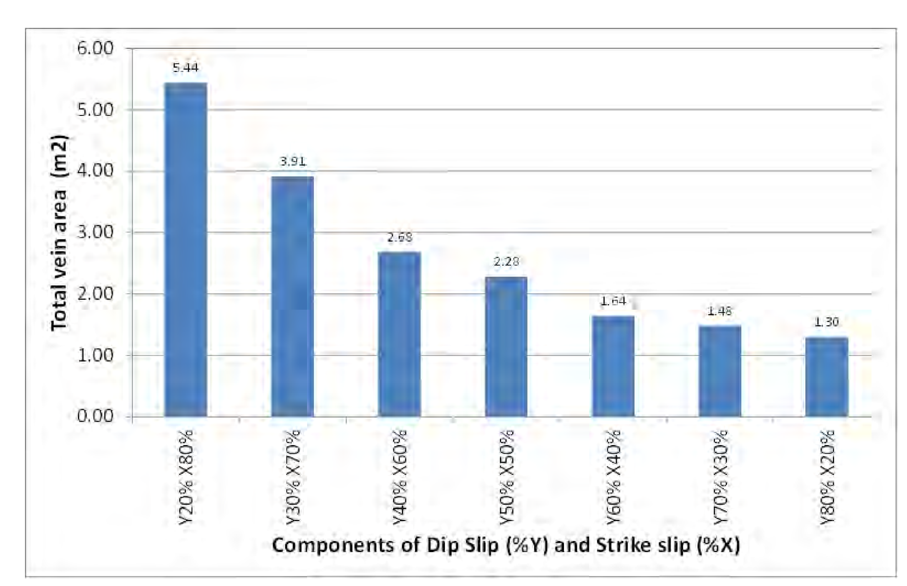


Y20 X80 Shearing Profile



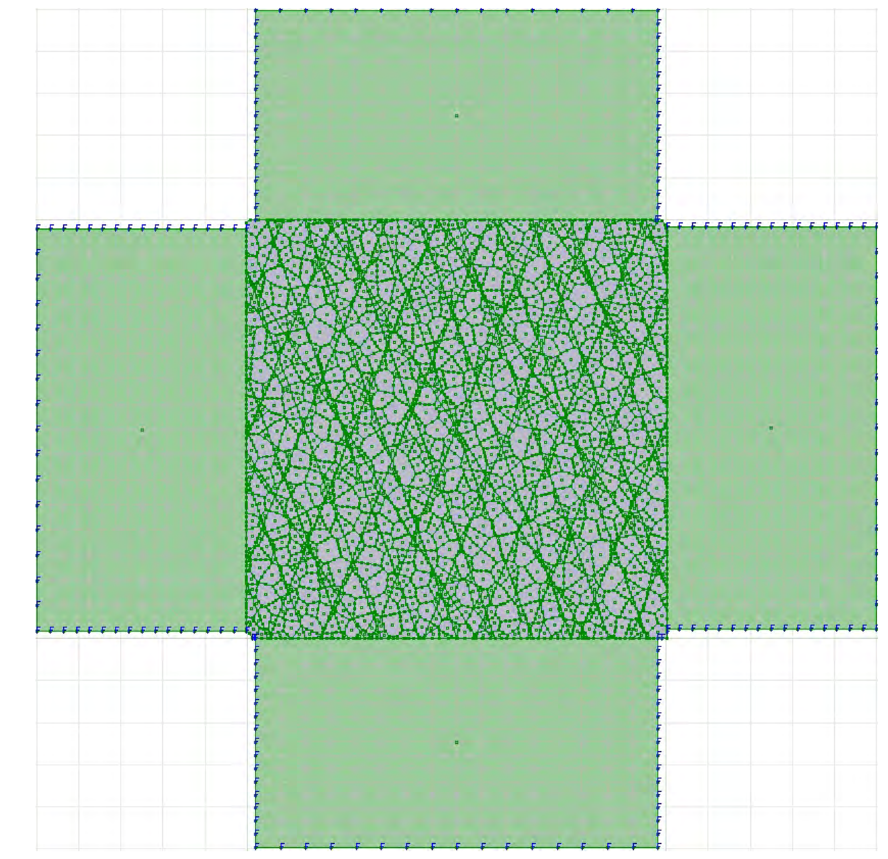
Y20 X80 Openings



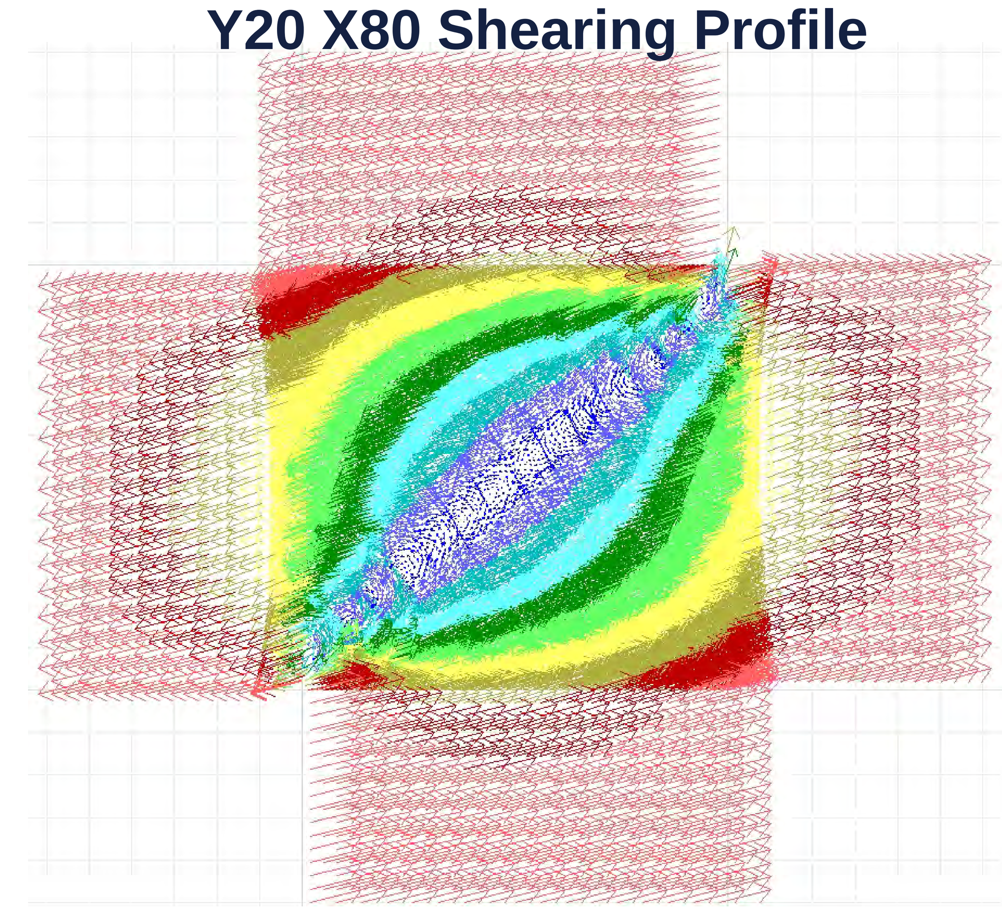


UDEC Alternate Orientation

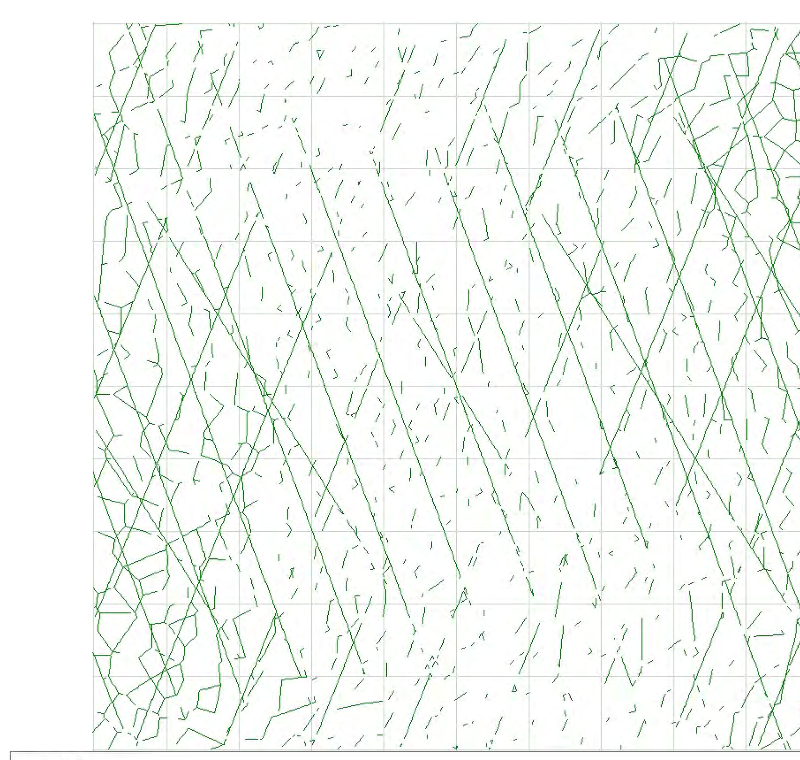
Unsheared model

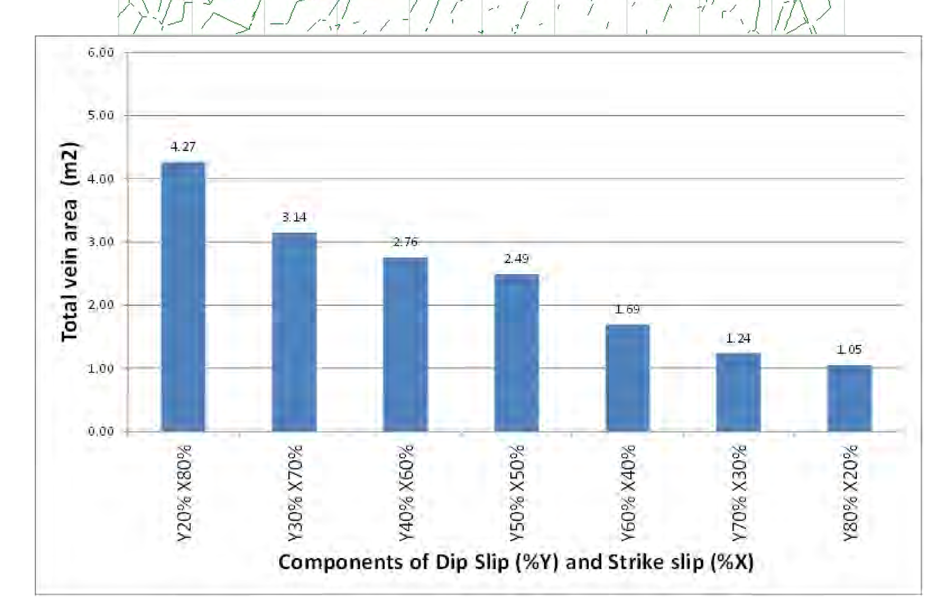


Y20 X80 Shearing Profile



Y20 X80 Openings





Conclusions

1) The highest volume of vein openings is for the strike slip dominated runs e.g. 20% dip slip 80% strike slip. This holds true for both orientations.
2) Vein apertures are a maximum of 0.20m in the models, whereas in the mapped chalcopyrite veins they reach 2.0m. Therefore, it is thought that another mechanism such as fluid overpressuring is required to form thick veins. This would work in conjunction with the high density of the fluid that would probably have been active for this type of vein mineralization. There may be depth regimes in which these factors together may be favourable. High density fluid would have a higher influence with depth due to the force of gravity.
3) Within the mapping of the chalcopyrite vein sets throughout the Whistle Offset there was a distinct relationship between vein sets and faults: i.e. Small faults of the type described here were always present for vein sets outside of the North Deposit. Therefore, this is an important observational criterion for further exploration in this area.