Identifying mineralization patterns using auto-correlation: Mount Isa Eastern Succession, NW Queensland, Australia.

1. Introduction
Australia’s Mount Isa Inlier in NW Queensland contains major copper +/- gold and Pb-Zn-Ag resources, making it one of the world’s premier mineral provinces. Understanding the structural controls on regional-scale ore localisation is an important aid to mineral exploration. This poster aims to define the regional structural controls on ore localisation in the eastern Mount Isa Inlier, using a 3 phase analysis:

1. Literature Review: Deposit-scale structural controls
2. Auto-correlation: analysis of mineralisation trends
3. Weights of Evidence: spatial associations of mineral deposits

2. Background
1. The Isaac Orogeny which occurred from 1.61-1.5 Ga left a record of complex deformation and a range of mineral deposits. It consists of several successive episodes, the major ones are: D1 - 1.615 Ma N-S thrusting, D2 - 1.585 Ma ENE-WSW folding and peak metamorphism, D3 - 1.527 Ma ESE-NWNNW folding, brecciation and pluton intrusion (ages summarised from Rubenach, 2003).
2. The timing of mineralization in the inlier is largely accepted to have occurred during two periods: 1.61-1.60 Ga for Pb-Zn-Ag and 1.60-1.50 Ga for Cu-Au mineralization (Mark et al., 2015).
3. Cu-Au deposits formed during reverse faulting/shearing after the ca. 1.505 Ma metamorphic peak and have a genetic relationship with 1.35-1.30 Ga A-type magmatism. (Mark et al., 2005)
4. Hatton and Davidson (2004) suggest that NNE-NE trending Au and Pb-Zn-Ag deposits were deposited on the sea floor during deposition of the 1.673-1.550 Ma Soldiers Cap group.
5. Carter (1961) and Lang (1986) propose that N and NW faults host both Cu-Au and Pb-Zn-Ag deposits while “Northwest faults are generally barren.” Carter (1961) also suggests that NE-NW NNW/ENE faults are two conjugate fault sets that form as a result of two successive stages of East-West stretching (1.60-1.50 Ga).
6. A prospectivity analysis by Muirhead et al. (2004) identifies the Dichtory Formation-Soldiers Cap Group contact (a NNW tectonic feature) and NE trending strike-slip faults to be highly prospective to Cu-Au mineralisation. These structures are interpreted to be two main components of a major geophysical lineament referred to here as the Cloncurry Worm (CW).

3. Structural controls / settings - deposit scale
Structural information can be found for 28 deposits in the study area (see table). Structural controls are sourced directly from the references (see figure 3) or inferred from 1:100,000 geological mapping where information is inadequate.
Structurally, there are three main types of deposit and several unique/more complex deposits.
1. North trending, iron formation-associated deposits that are Pb-Zn-Ag rich.
2. North trending, iron formation-associated deposits that are Cu-Au rich.
3. Copper or gold dominated deposits that occur along, or at the intersection of syn- to post-orogenic, variably oriented faults. This may be evidence of copper / gold remobilization.

NB: The three largest deposits (e.g., Carnington, Eloise, Ernest Henry) have more complex fault geometries than smaller deposits.

4. Auto-correlation - regional scale
Auto-correlation is used to delineate patterns of mineral deposit distribution by defining the spatial relationship of each deposit to all others. MINOCC (2002) data was sorted into Pb-Zn-Ag, Cu, Cu-Au, Au-Cu, and Au deposit types. Patterns of deposit locations are revealed by plotting the ends of vectors drawn from each deposit in turn at the centre of the plot to every other deposit. The resultant XY plots and rose diagrams are shown here:
1. Cu-Au deposits show strong N-NW trends as well as NSE and SE trends.
2. Cu deposits have strong NNW and N-S trends
3. Pb-Zn-Ag deposits show strong N and NNE trends
4. Au+Cu deposits show 5 different trends: N-S, NE, ENE, ESE, SE; these correlate with a variety of late faults.

6. Conclusions
- Weights of Evidence analysis indicates that mineral deposits in the study area have a strong correlation with the Cloncurry worm.
- Cu and Au deposits have a stronger spatial association than Ag-Pb-Zn and Cu-Au deposits.
- Auto-correlation analysis shows N-NW Cu-Au trends and N & NNE Pb-Zn-Ag trends, which correlate to north trending iron formation deposits in table 1. There are Cu-Au rich and Pb-Zn rich end members.
- These trends are generally deducing parallel and probably reflect the stratiform nature of these deposits. It is also possible that the ironstones have formed in N-trending normal or dip-slip faults (e.g., the N-S Levuka shear zone).
- Au+/Cu deposits have moderate NE, ENE, ESE, SE trends and have a strong spatial association with the Cloncurry worm. These deposits reflect secondary mineralisation along variably oriented late syn- to post-orogenic faults.
- Cu deposits have a strong NNW trend and have a strong spatial association with the Cloncurry worm in the weights of Evidence analysis, and thus appear to be structurally controlled by the Cloncurry Worm.