DISCUSSION
Damage zones are critical components of a fault system (Chester and Logan, 1986; Odling et al., 2004; Cochran et al., 2009). In the Carlin-type ore deposits of the northern Carlin trend a combination of field observations and numerical modelling indicate that wall-damage and linking-damage zone structures controlled the migration of fluids and influenced the gold-field-scale location of mineralization. The damage is both off-fault and located in the near-field of the Post-Genesis fault system, and is unusual because it formed along pre-existing planes of weakness, such as dike margins, fold limbs and old reverse faults.
Damage zone faults associated with mineralization in the northern Carlin Trend, extend up to 2 km laterally from the master fault, across strike. This width narrows significantly with depth and mineralization becomes localized adjacent to the fault plane, and in stepover domains (e.g. Heitt et al., 2003). Furthermore, deep mineralization has been discovered at the northern tip of the Post fault segment and in the hanging wall of the Post fault segment.
Stress Transfer Modelling can be used to explain the distribution of mineralisation in the Carlin trend. Positive changes in static stress, from slip events on the Post-Genesis fault system, correlate with the distribution of mineralization. This suggests a model whereby static stress changes triggered slip on pre-existing weak surfaces or faults, induced damage, and exerted a first-order control on the enhancement of permeability. Some important implications of the modeling are that the depth extent of damage is potentially much greater than the dimensions of the fault system and could have reached to 15 km (i.e. a fullfault segment length below the base of successive ruptures). Fault tips and stepovers in a system are critical domains but there are also important non-intuitive domains influenced by physical and geometric factors such as fault shape and far-field stress regime. STM is a useful tool for understanding the non-intuitive
distribution of fault-related damage that controlled permeability enhancement and mineralization in any system (Micklethwaite and Cox, 2004, 2006). For example, in the Post-Genesis fault system, static stress changes provide a rationale for understanding the footwall scallop of mineralization represented by the world-class Betze-Post and Genesis pits. The approach outlined here provides a physically sound basis to understand fluid migration and the distribution of mineralization. On the meter scale physico-chemical processes such as reaction-enhanced porosity may well be important, which possibly explains the presence of approximately stratiform mineralization in places. However, the first-order control, on the goldfield scale, was faulting and fracturing related to slip events on the Post-Genesis fault system. Fluid flow during Carlin-type mineralization has previously been interpreted as “passive” (Cline et al., 2005), meaning that mineralizing fluids exploited pre-existing, quasi-permanent porosity networks, such as fractures and bedding horizons. However, the results of this study suggest that porosity was generated by the faulting process, perhaps repeatedly. Mineralization was dependent on slip events on the Post-Genesis fault system, which possibly resulted in cycles of coseismic fracturing and interseismic healing (Micklethwaite et al., 2010). During and following a slip event, fluids migrated through the fault core and damage zone of the Post-Genesis fault system, before reacting with and mineralizing suitable lithological hosts.