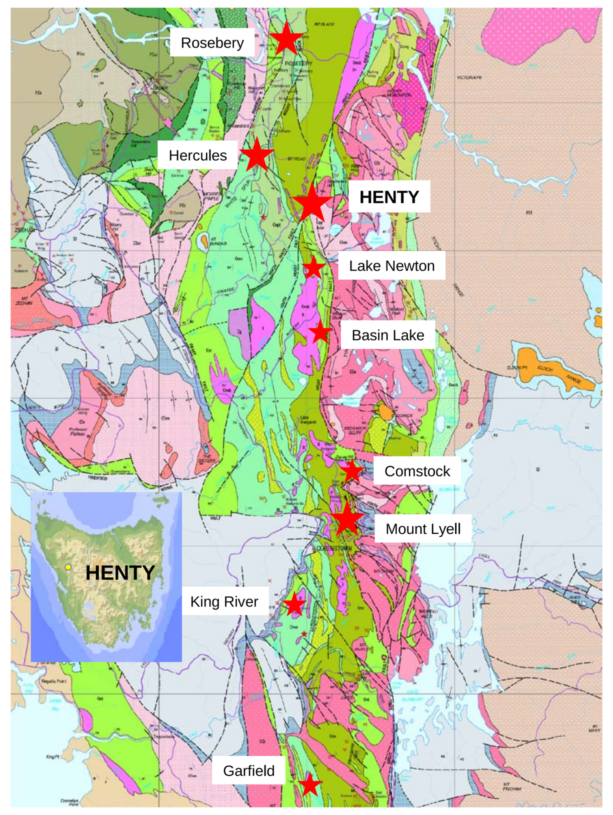
SWIR Study of alteration mineralogy at Mount Julia (Henty)



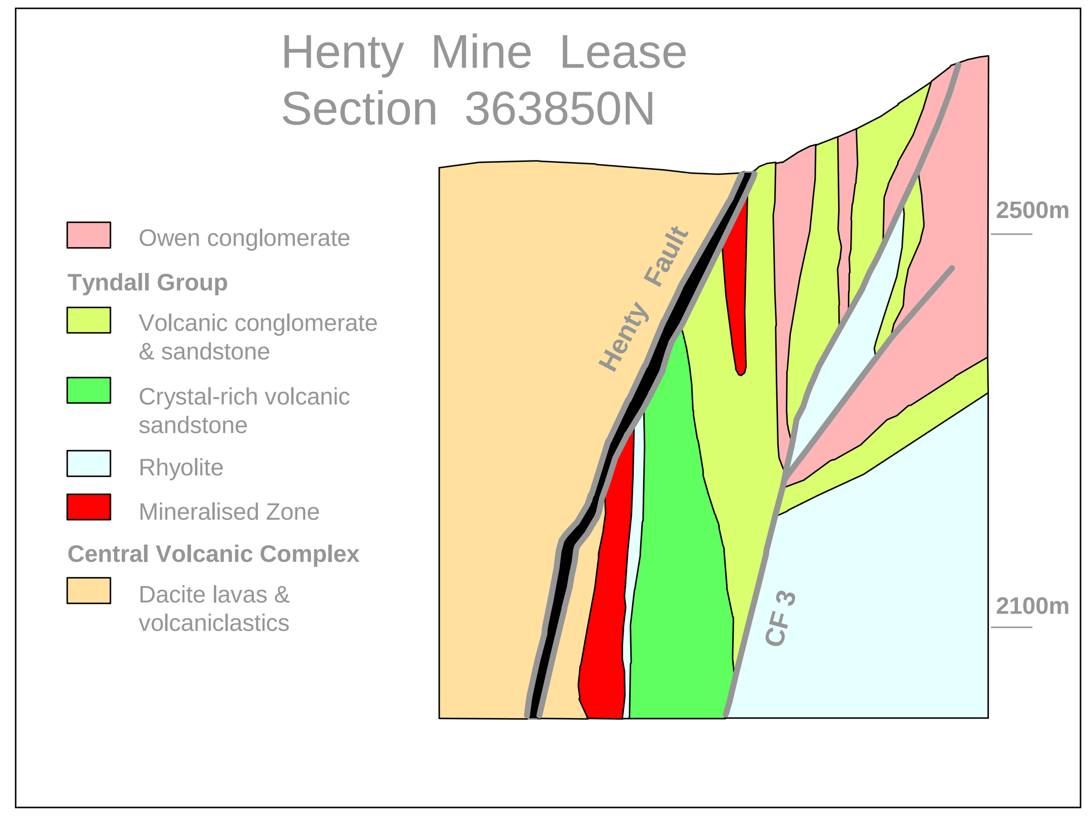
Henty is an enigmatic deposit with few analogues elsewhere in the world. Henty occurs in a renowned VMS province and it has some attributes in common with VMS-style systems, but in other regards, particularly the metal assemblage, it is very unlike VMS deposits.

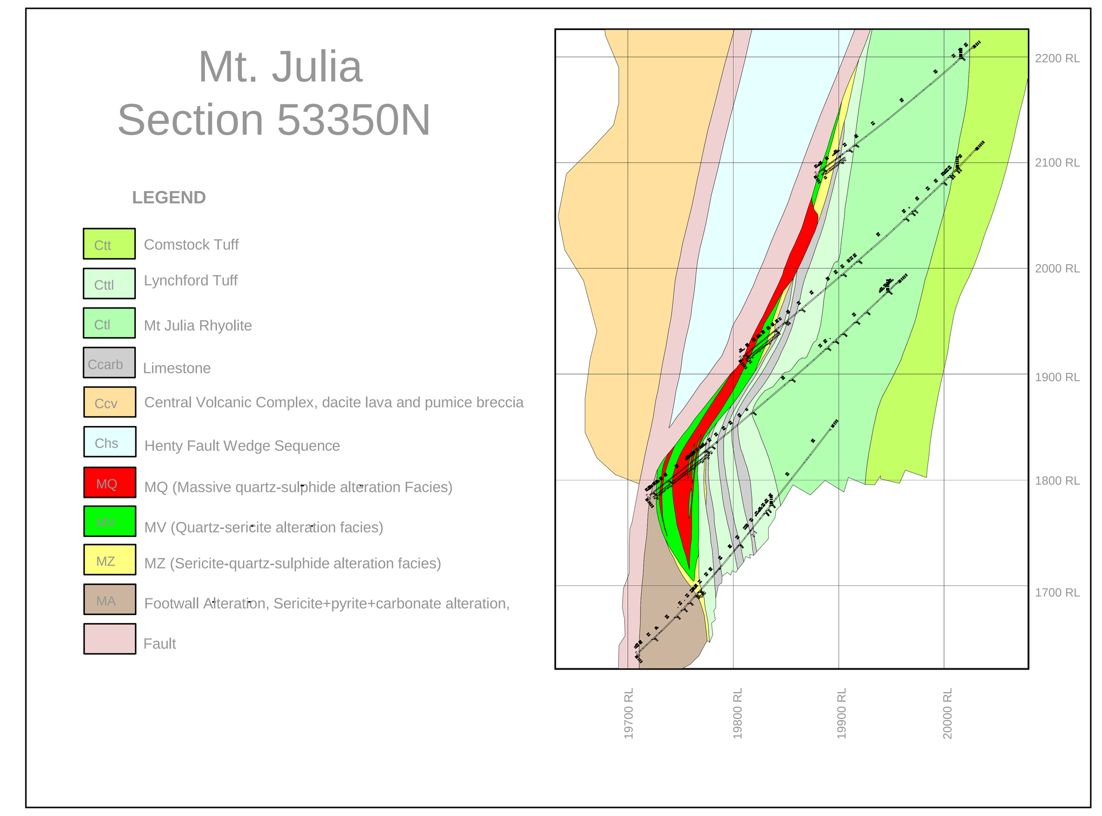
S, C, O and Pb isotopes provide strong evidence that Henty was formed during the Cambrian from a seawater dominated hydrothermal system at relatively low temperatures, around 200 degrees.

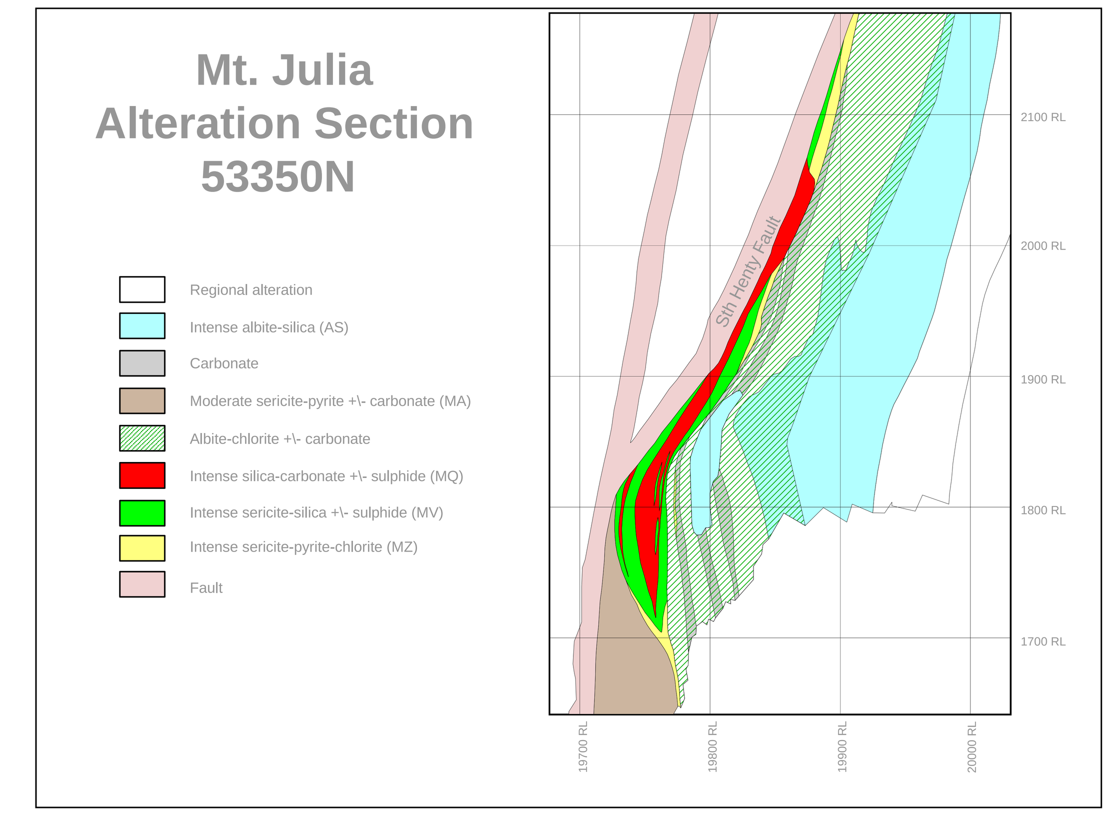
Stratigraphically below Julia/Darwin there are zones of quartz, pyrophyllite, topaz alteration, surrounded by Na-depleted sericitic alteration. This style of alteration is typically associated with high sulfidation environments peripheral to porphyry copper deposits. The acidity is generated by magmatic volatiles containing SO2. This style of alteration is common around Mount Lyell, particularly around the bornite orebodies.

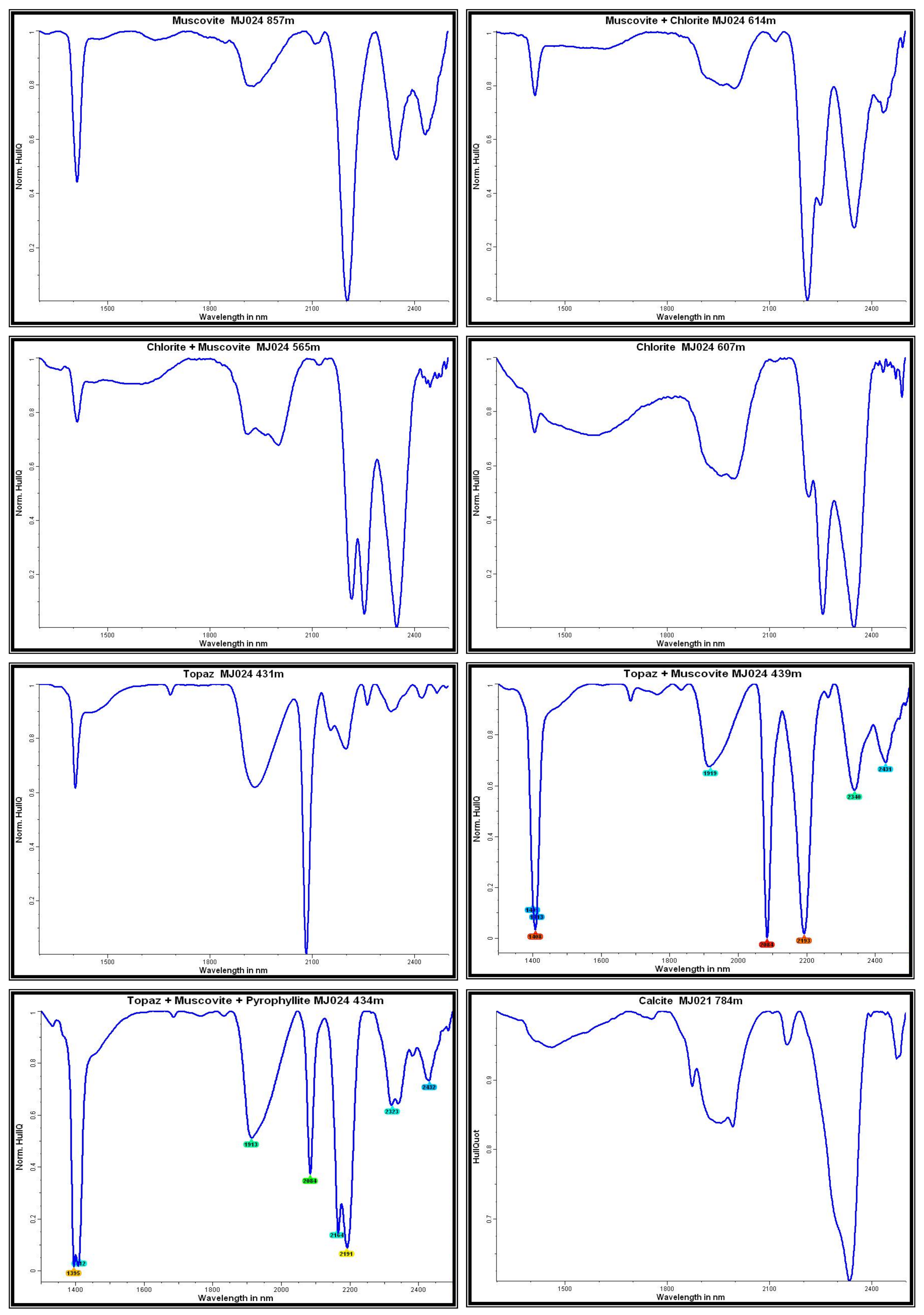
The Prince Lyell orebody at Mount Lyell has many characteristics of porphyry copper deposits. Lyell Comstock is the only location at Mount Lyell where a complete section from a copper orebody to a seafloor position is preserved. At Comstock, there are small Prince Lyell type Cu-Au orebodies with a halo of high sulfidation type alteration and a silica cap just below the seafloor position that has the same chemical characteristics as the MQ (silica-rich ore zones) at Henty. This is flanked by small sulfide lenses, bedded carbonates and red jasper.

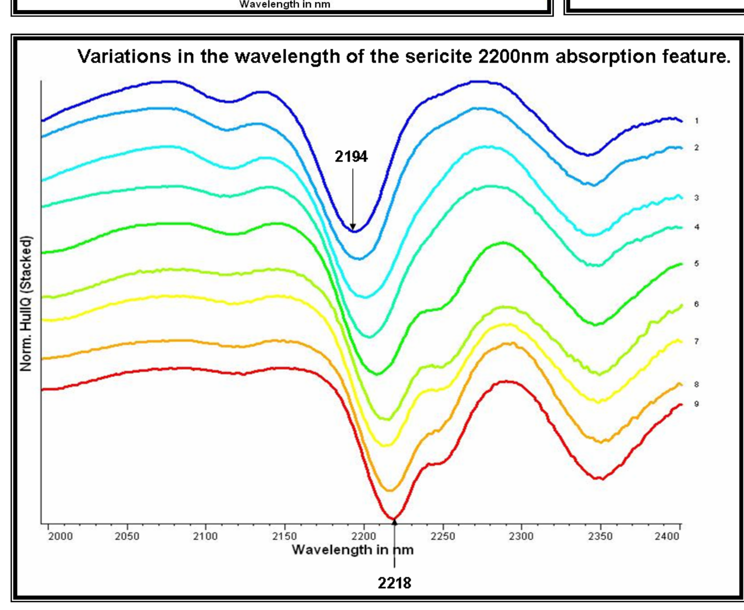
The Mount Lyell and Henty deposits are interpreted to be a continuum of porphyry copper to high sulfidation to epithermal deposits formed in a shallow submarine setting. Although Henty is dominated by fluids with a seawater-dominated signature, it must also have a significant magmatic component to account for the unusually acidic footwall alteration.







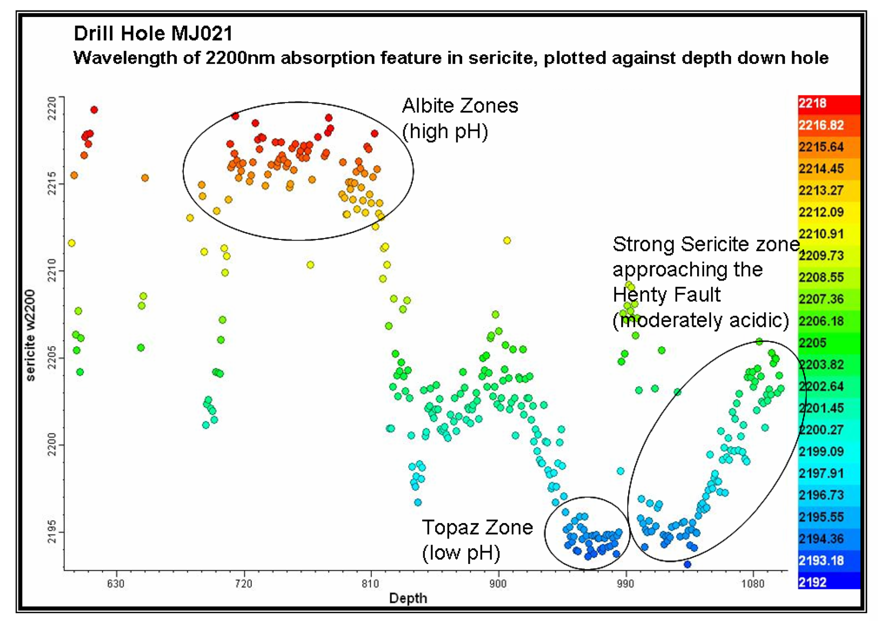




The 8 spectra above show the ranges of minerals most commonly measured in this survey. As well as sericite and chlorite, there is a complete range of sericite-chlorite mixtures. Similarly, there are mixtures of topaz, sericite and pyrophyllite, and mixtures of calcite, sericite and chlorite.

The wavelength of the Al-OH absorption feature in the sericites is highly variable. It ranges from 2193nm to 2222nm. An example of this variation is shown on the left. As well as interpreting the dominant alteration mineralogy, the wavelength and depth of the Al-OH absorption feature in mica-bearing samples are important parameters to extract from the data.

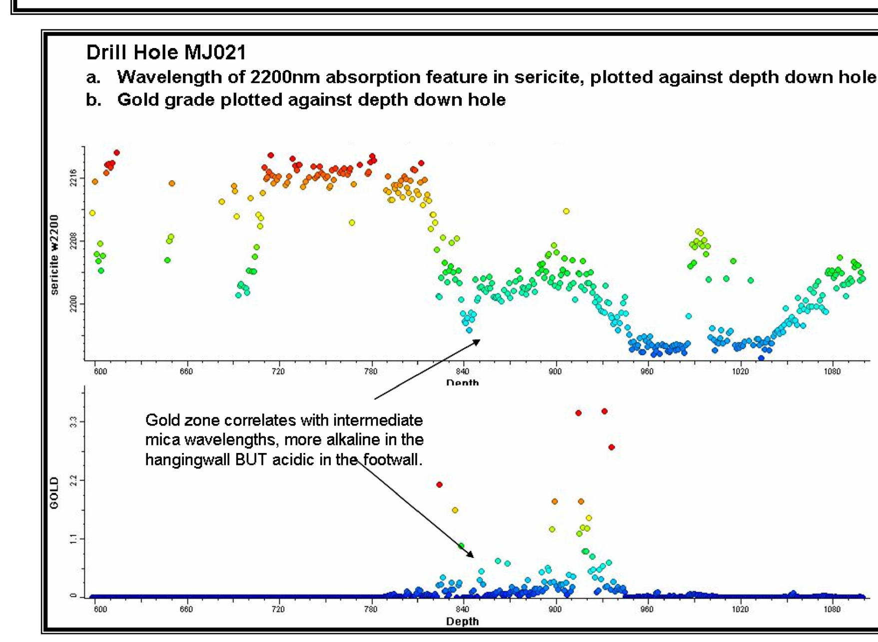
The short wavelength sericites are close to a stoichiometric muscovite composition. As more Fe and Mg substitute for Al in the octahedral sites, the Al-OH feature shifts to longer wavelengths. The variability shown to the left is mapping the muscovite-phengite solid solution in the white micas.

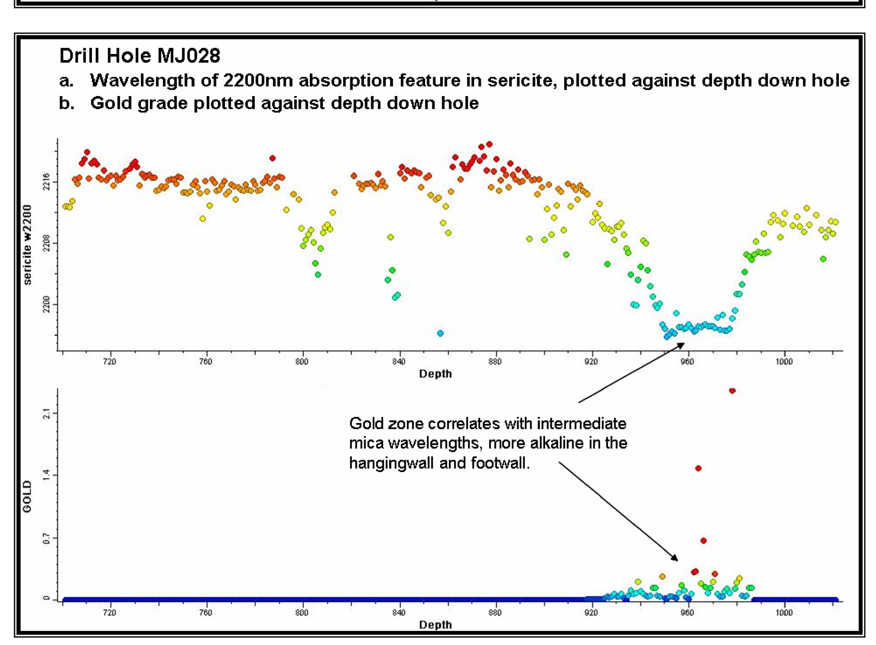


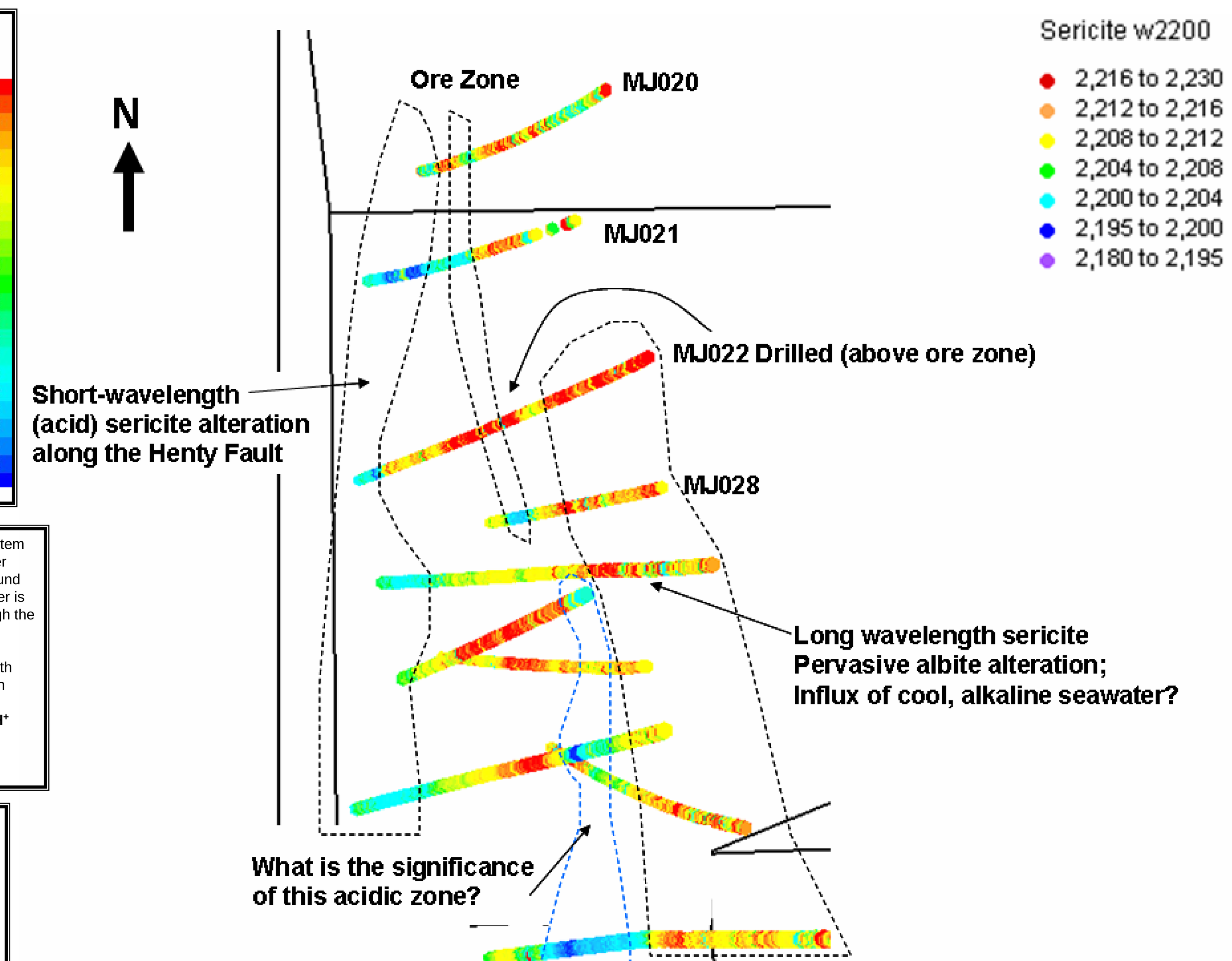
Henty has some VMS-style mineralisation, but this system looks like it was buried while the hydrothermal system was still active. In particular, it was capped by a series of rhyolite sills. The acid alteration pipes in VMS feeder zones are well documented in the literature, but most VMS systems also have a halo of pervasive albite. Around the margins of VMS alteration pipes there is often a shallow level convective inflow of cool seawater. Seawater is alkaline and Na-Mg rich. As the cool seawater is heated, it precipitates albite, calcite and Mg-chlorite. Although the halo to the ore, and parts of the footwall are sericite-rich, albite is volumetrically the most abundant alteration mineral in this system, especially in the hangingwall rhyolites. The figure above shows that short Al-OH wavelength micas occur in proximity to the acid topaz-bearing zones. Long Al-OH wavelength micas occur with the albite alteration, where the fluids are obviously much more alkaline. If we write an Al-conservative reaction between a theoretical phengite end member and muscovite, then it contains a pH term;

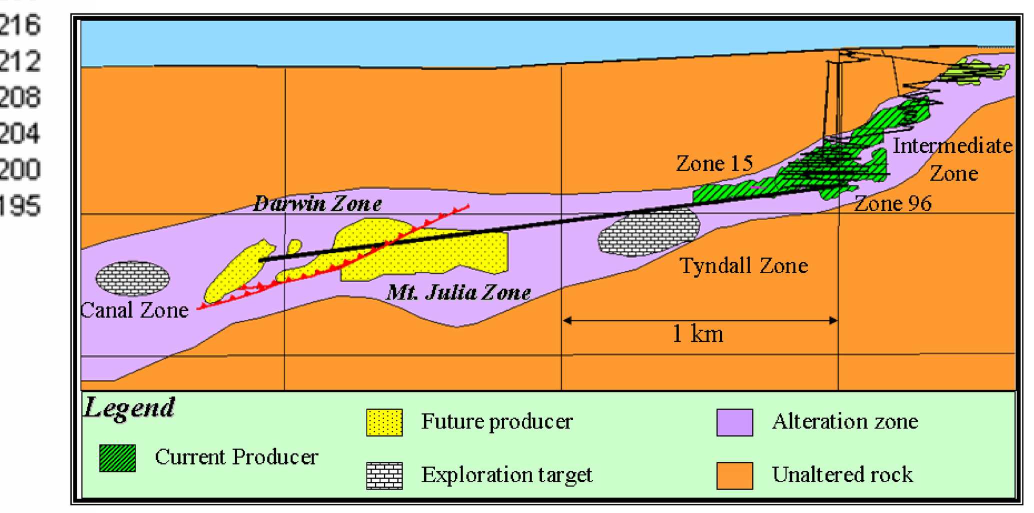
$2KAl_2(AlSi_3)O_{10}(OH)_2$ (musc) + K^+ + $1.5Fe^{2+}$ + $4.5SiO_2$ + $3H_2O$ $\Leftrightarrow$ $3KFe_{0.5}Al_2(Al_{0.5}Si_{3.5})O_{10}(OH)_2$ (phen) + $\mathbf{4H^+}$

The wavelength of the Al-OH feature is essentially mapping the pH of the hydrothermal system. Short wavelengths occur in acid zones, forming very broad haloes around the topaz-pyrophyllite. Long wavelength micas occur with albite-calcite +/- chlorite.



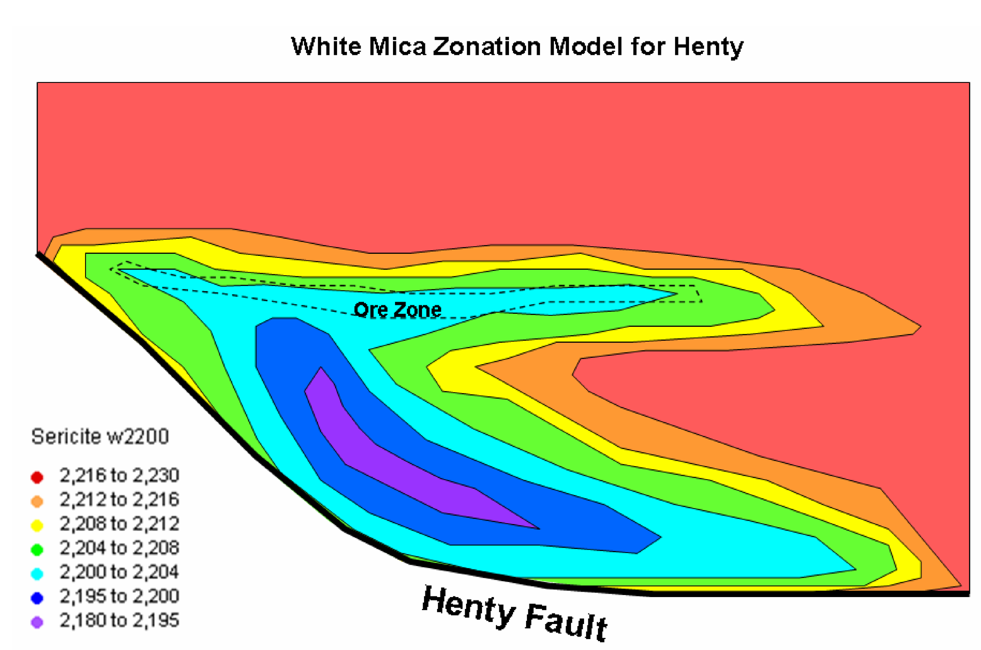






A second zone of topaz was detected in hole MJ024 at about 500m below surface. The adjacent holes had shorter wavelength micas at the equivalent stratigraphic position. Could this be a feeder into another "Darwin Zone" high grade shoot?

The spectral analysis clearly defines this as a target zone requiring more drilling.



Henty contains small shoots (~200m by 100m by 5m thick) of high grade ore (>15g/t). The current mining area is around 800m below surface. Drill testing for extensions along strike is done from surface as this is ahead of underground development. The drilling is expensive and the targets are small, so it is important to be able to recognise a near miss.

The Darwin Zone appears to have a feeder defined by intensely acid alteration (topaz-pyrophyllite) with a halo of moderate acidity. Drilling into the orebody goes from albite-phengite (long wavelength micas) in the hangingwall, to strongly sericitised moderate wavelength micas in proximity to the ore, to topaz-pyrophyllite-short wavelength micas in the footwall. Towards to margins of the Darwin Zone, holes go from long wavelength micas in the hangingwall, to strongly sericitised moderate wavelength micas in proximity to the ore and back to long wavelength micas in the footwall. The short wavelength mica zone ahs a mushroom shape, with albite-phengite occurring in the footwall on the margins of the system. Gold is soluble as a chloride complex in hot saline, oxidised and acid fluids, eg, in a high sulfidation environment. Mixing with cooler, alkaline seawater would be a very effective way to precipitate the metal.