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The State of Equilibrium and Ore Mineralization in  
Core Hole VC-2a, Sulfur Springs, Valles Caldera,  
New Mexico

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The Continental Scientific Drilling Program core hole located at Sulfur Springs penetrates the most intensely altered and thermally active portion of the Valles Caldera complex. It was anticipated that Creede-type mineralization might be discovered in VC-2a. Instead of Creede-type mineralization, alteration in VC-2a includes a sub-ore grade epithermal molybdenum deposit - a unique occurrence in an active geothermal system. Molybdenite mineralization associated with quartz, illite, and pyrite is mostly concentrated between 24.9 and 163m depth. Molybdenite and associated minerals occur as delicately banded veinlets and vug linings. Other phases found less commonly in the molybdenite zone are fluorite, gypsum, sphalerite, and rhodochrosite. Veins show a complex sequence of mineralization evolving with time : molybdenite-pyrite-illite-quartz; quartz; quartz-illite; quartz; fluorite; rhodochrosite-sphalerite. Fluid inclusion temperatures show all assemblages crystallized at about 200°C .

The phase relations of the solid phase assemblages are compared with observed fluid compositions from a related well (WC-23, at 214°C ) about 2km distant, and contemporaneous fluids extracted from VC-2a by down hole fluid sampling at 210°C . Solubility constants are calculated using the SUPCRT database at 200°C , 15.5 bars, and ionic strength=0.15. Six component models for both illite and chlorite are used to determine mixing effects for these solid solutions. Calculations were performed to define the conditions of crystallization of molybdenite and its subsequent disappearance at depth greater

than 163m. Molybdenite is rare after the appearance of chlorite at depth greater than 163m. Figures 1 and 2 show the results of preliminary calculations.

Chlorite-pyrite±quartz found a greater depths probably saturated under more reducing conditions than the illite-molybdenite-pyrite-quartz assemblages found in the mineralized zone. Although a definite sequence of deposition of alteration is observed in the mineralized veinlets, it is possible to crystallize all non-chlorite bearing phase assemblages at near neutral pH and oxygen fugacities near hematite-magnetite at 200°C and 15.5bars total pressure.

### Figure Captions.

Figure 1. Isothermal-isobaric Log  $f_{O_2}$  -pH diagram at 200°C and 15.5bars showing reaction relations in VC-2a in the vicinity of 163m using WC-23 water:  $\Sigma S=.00034m$ ,  $K=.012m$ ,  $Fe=.00014m$ ,  $Mg=.00012m$ ,  $Ca=.002m$ ,  $Zn=.000066m$ ,  $\Sigma C=.054m$ , and  $Mn=.0004m$ . Where, hem = hematite, ill = illite, chl = chlorite, py = pyrite, mag = magnetite, rho = rhodochrosite, po = pyrrhotite, cp = chalcopyrite, and bn = bornite.

Figure 2 Expanded portion of Figure 1 showing an assemblage of at least eight phases (including quartz and molybdenite) may crystallize isobarically and isothermally at near neutral pH and  $f_{O_2}$  near the hematite- magnetite oxygen buffer.

Fig 1

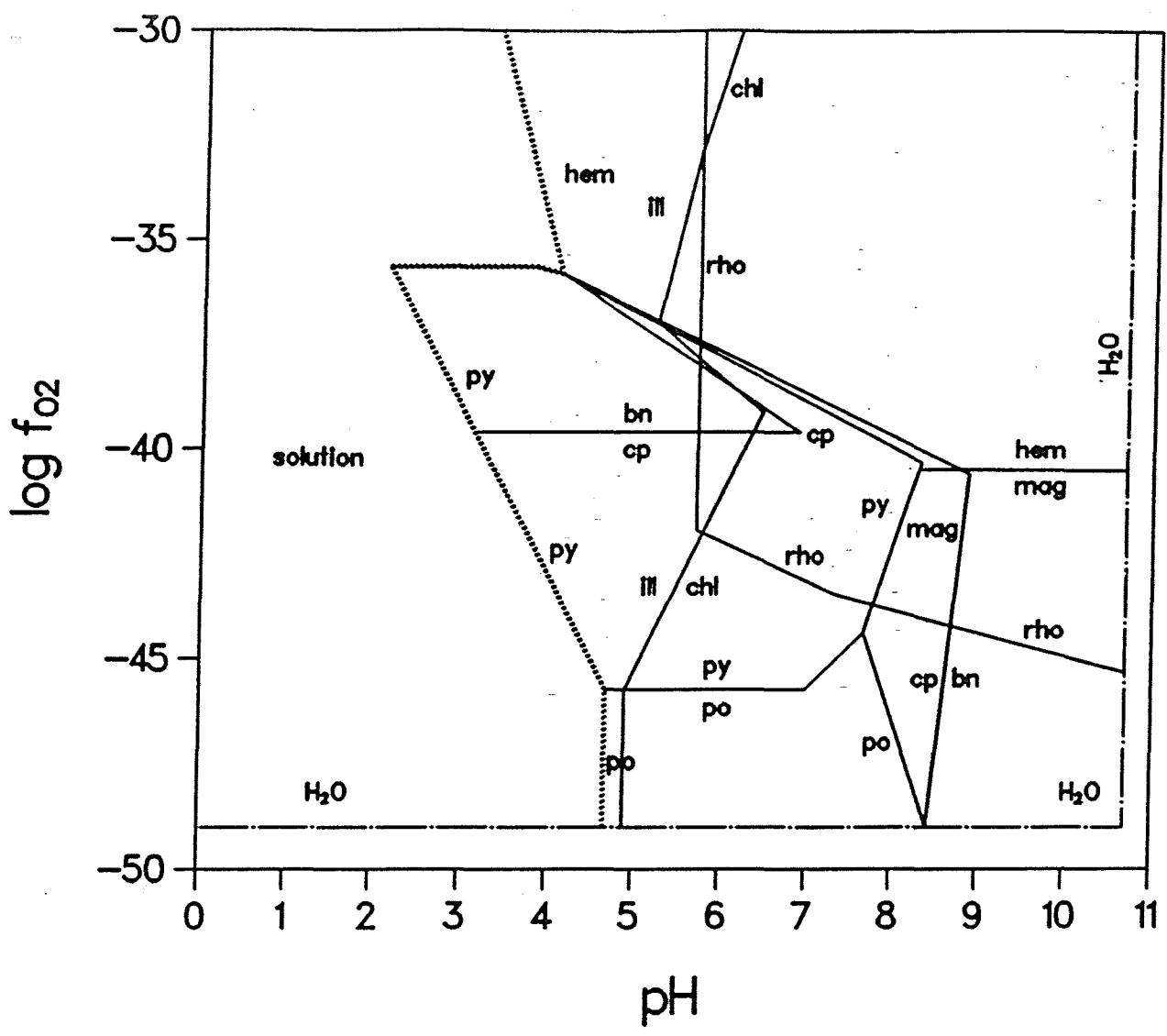


Fig 2

