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Tracing styles of hydrothermal circulation in Manus Basin using vent fluid composition

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Hydrothermal fluids were collected in August 2007 from several active vent fields in the Manus Basin back-arc environment to constrain sub-seafloor processes associated with the formation of seafloor metal sulfide deposits. In this area, fluids vent from black smoker chimneys, white smoker spires, and igneous and sediment substrates. A broad spectrum of fluid compositions is associated with diverse styles of venting, reflecting key subsurface processes that regulate the evolution of fluid chemistry. Fluids venting at 273 to 285˚C at the basalt-hosted Vienna Woods system (Manus Spreading Center) indicate that the composition and pH of black/grey smoker fluids are similar to fluids sampled from other basalt-hosted (e.g., mid-ocean ridge) systems. In general, fluids from felsic-hosted systems are characterized by lower pH and greater compositional variability than fluids from basalt-hosted systems. For example, high temperature (270 to 358˚C) fluids from the PACMANUS and SuSu Knolls areas exhibit pH values and H_2S concentrations that vary from 2.3 to 3.5 and 2.5 to 26 mmol/l respectively. Many of these fluids contain high concentrations of Mg (up to 17 mmol/kg) that cannot be attributed to entrainment during sampling, suggesting that extensive mixing of seawater is occurring in the subsurface prior to venting. The SuSu Knolls fluids also contained variable, but relatively high concentrations (up to 0.5 mmol/l) of aqueous CH_4 consistent with thermal alteration of organic-bearing sediments. Lower temperature (47 to 241˚C) white smoker fluids venting directly from substrate and hydrothermal sediment at the SuSu Knolls and DESMOS areas are more acidic with pH values that vary from 0.9 to 1.5. These extremely low pH fluids are characterized by aqueous sulfate concentrations that are substantially higher than seawater values, rela-

tively low aqueous H_2S concentrations, and white smoke formed by the precipitation of elemental sulfur. Both high and low temperature fluids in the felsic-hosted systems contain aqueous fluoride concentrations that are above seawater values. High SO_4 and F abundances suggest that these fluids represent a mixture of magmatic volatiles and a seawater-derived hydrothermal fluid. Many of the fluids have chlorinities that are higher than seawater suggesting that phase separation is a pervasive phenomenon.

The extreme compositional variability exhibited by high temperature black/grey smoker fluids and low temperature highly acidic white smoker fluids can be attributed to large differences in the extent of fluid rock reaction and the style of hydrothermal circulation. In particular, the chemistry of high temperature fluids reflects the integrated effects of mixing between a seawater-derived hydrothermal fluid that has undergone extensive fluid-rock reaction during deep-seated convective circulation and magmatic volatiles. In contrast, the chemistry of the low temperature low pH fluids is consistent with mixing of magmatic volatiles and pristine seawater that has not experienced extensive fluid-rock reaction. The diverse origin of these fluids allows an assessment of the relative roles of magmatic fluids and fluid-rock interaction during the formation of seafloor metal sulfide deposits.