

ISOTOPIC COMPOSITIONS OF  
RES

, Department of Geosciences, The  
ersity Park, Pennsylvania 16802

ng fluid-rock interactions  
affected by equilibrium tempera-  
a the hydrothermal fluid.  $\delta D$   
y: (1) source of the hydro-  
; (2) isotopic exchange history  
the physico-chemical state of  
a dependent on (3) because any  
lter both the relative propor-  
CH<sub>4</sub>, CO<sub>2</sub>, CO), and the isotopic

e isotopic fractionation factors  
anges in T, Pfluid, fO<sub>2</sub>, and  
isotopic equilibria among fluid  
eologically important fO<sub>2</sub> region  
eral buffers W-M, and M-H), a  
se large changes in  $\delta D$  and/or  
d from the fluid. For example,  
<sup>18</sup>O values of minerals formed  
ffer by more than 30% and 5%,  
ate of the fluid. This implies  
igin of fluids from  $\delta D$  and  $\delta^{18}O$   
physico-chemical parameters  
tion can be estimated.

## ITHOPHORE DISTRIBUTION

drew, Lamont-Doherty Geolo-  
niversity, Palisades, New

communities were studied at  
approximately 600 samples  
0m and 100m. Significant an-  
stations in terms of the stand-  
er temperature. The season-  
erally similar to each other  
ed, although, occasional barren  
rgeest standing crops were as-  
s. Most species ocured only  
omenon was repeated year  
each species, however, varied  
ption of Emiliana huxleyi  
r. As already shown in the  
tions and the seasonal varia-  
100m level from that of the  
ved, a fairly large number of  
d water, and more detailed  
inum and optimum water tem-  
s. In addition to the semi-

monthly samples, some semiweekly and daily samples were also col-  
lected to examine the short term variations of the flora. While  
species composition was found to be relatively consistant within these  
samples, the standing crop showed great variation.

VADOSE PRECIPITATION OF HIGH MAGNESIAN CALCITE AND ARAGONITE IN THE  
MONARCH MINE, KICKING HORSE PASS, BRITISH COLUMBIA

Oldershaw, A. E.; McIlreath, I. A.; Ghent, E. D.; Department of  
Geology, University of Calgary, Alberta, Canada  
Dolomite clasts on the floor of the East Monarch Mine are undergoing  
rapid lithification by precipitation of high-magnesian calcite and  
aragonite. Precipitation is taking place at present and appears to  
have been continuous for a maximum of 70 years and a minimum of 20  
years.

High-magnesian calcite, aragonite and intergrowths of these two  
minerals form alternating, roughly concentric bands around angular,  
grain-supported dolomite clasts. The resulting fabric is comparable to  
that of vadose pisoliths described from other localities, including the  
development of pendulous rims on the lower surfaces of the clasts and  
the occurrence of inverse grading of the "pisoliths".

The high-magnesian calcite (average 12 mol% MgCO<sub>3</sub> by microprobe)  
exhibits a blocky sub-rhombic crystal form with maximum crystal dia-  
meters ranging from 0.5 $\mu$  to 3.0 $\mu$ . Aragonite, identified by XRD, con-  
tains an average of 1 mol% MgCO<sub>3</sub> and occurs as twinned, fibrous to  
bladed crystals from 0.25 $\mu$  to 3.0 $\mu$  wide and 10 $\mu$  to 50 $\mu$  long: the ara-  
gonite exhibits both an oriented and a tangential fabric relative to  
the clast surfaces. In the mixed zones, aragonite adopts a rosette  
form and the high-magnesian calcite tends to be more equicrystalline  
and of a finer crystal size.

The source of the precipitating carbonates is inferred to be mete-  
oric ground waters percolating through an overlying dolostone source  
rock. Variations in mineralogy and crystal morphology can be explained  
by semi-seasonal fluctuation in ground water chemistry, particularly  
magnesium ion concentration.

## LEACH HOT SPRINGS GEOTHERMAL AREA, NEVADA

Olmstead, F. H., U. S. Geological Survey, Water Resources Division,  
Menlo Park, California; Van Denburgh, A. S., U. S. Geological Survey,  
Carson City, Nevada

Leach Hot Springs are in southeastern Grass Valley, about 45 km by road  
south of Winnemucca, Nevada. The springs issue from steeply inclined  
fault-controlled conduits in Quaternary alluvium and Tertiary nonmarine  
sedimentary rocks. Late Paleozoic and early Mesozoic sedimentary and  
volcanic rocks are exposed east of the springs and probably underlie the  
spring area at depths of no more than a few hundred metres. Total dis-  
charge of thermal water is about 3-5 x 10<sup>5</sup> m<sup>3</sup> yr<sup>-1</sup>, most of which is  
springflow from 30 orifices. Discharge temperatures in November 1973  
ranged from 34.5°C to 95.5°C (boiling); the weighted average was 76°C.  
Dissolved solids, dominated by sodium, bicarbonate, and silica, total  
about 580 mg l<sup>-1</sup>. Estimated reservoir (equilibrium) temperature is 155°C  
by the silica-quartz geothermometer or 176°C by the sodium-potassium-  
calcium geothermometer. The thermal anomaly associated with the spring  
system is defined by temperatures greater than about 15°C at a depth of

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30 m below land surface. The anomaly forms an ellipse with the major axis oriented northeastward, along the fault that controls the position of the hot springs. Comparison of the temperature pattern with the configuration of the water table indicates that transport of heat by lateral flow of thermal ground water is not significant at shallow depths. Total discharge of heat from the system is about  $1.8 \times 10^6$  cal  $s^{-1}$ , of which  $1.0 \times 10^6$  cal  $s^{-1}$  is conduction through near-surface materials within the area of the thermal anomaly and the remainder is the heat carried by the spring discharge.

GEOHERMAL RESOURCE CHARACTERISTICS,  
EXPLORATION CONSIDERATIONS AND PROPERTY ACQUISITION TECHNIQUES

Harry J. Olson and William M. Dolan, Amex Exploration, Denver, Co.

World wide experience demonstrates rather conclusively that geothermal reservoirs are more closely related as far as geological occurrence, and exploration and development techniques are concerned to conditions encountered by the mining industry than those encountered by the petroleum industry. To date, however, the majority of geothermal activity in the United States has been undertaken by the petroleum industry or related organizations not only because of the energy relationship but also because property acquisition practices and overall exploration costs have a more direct bearing to the oil and gas experience.

Due to high land acquisition and evaluation costs, and because of long developmental lead time, complex marketing problems and the necessity to develop a technical capability to handle a wide range of geothermal fluids, the high degree of inherent risk in geothermal ventures requires that costs related to the discovery and definition of the resource be held to a minimum. This can be accomplished by avoiding large lease bonuses and rentals for unevaluated and untested properties, by joint venture arrangements whereby a degree of the risk is spread, and by exploration agreements that permit a timely evaluation of the geothermal potential without a commitment to large capital expenditures.

CHEMICAL INTERACTIONS DUE TO SUBSURFACE MIXING OF METEORIC AND MARINE WATERS IN A PLEISTOCENE REEF COMPLEX, RIO BUENO, JAMAICA

O'Neil, Thomas J., Department of Geological Sciences, University of Southern California, Los Angeles, California, 90007

An investigation was made of geochemical processes occurring during subsurface mixing of meteoric and marine waters within a Pleistocene reef complex along the north coast of Jamaica. Water samples from local sea water, four shallow wells along a transect normal to the strand line, and a fresh water spring were monitored over a four-week period for Na, Mg, Ca, K, Sr, Cl,  $SO_4$ , pH, and alkalinity.

Na, K, Cl, and  $SO_4$  behave conservatively during mixing and decrease in concentration inland toward fresh water recharge zones. Variations in Ca, Mg, Sr, pH, and alkalinity, however, reflect variations occurring between water and sediment in the zone of mixing. Thermodynamic calculations indicate that meteoric water is saturated with respect to magnesian calcite and slightly undersaturated to aragonite and dolomite. Waters in the zone of mixing are slightly undersaturated with respect to magnesian calcite and aragonite, but supersaturated to dolomite. Solution cavities in sediments of the mixed zone reflect dissolution by waters undersaturated in magnesian calcite

and aragonite. Further sampling of dolomite cements.

Decreased saturation of carbonate solid phases results in changes in ionic strength.

THE MAGNETIC POLARITY STRATIGRAPHIC SEQUENCE AT ANZA-BORREGO STAT

Opdyke, N.D., Lamont-Doherty Earth Observatory, Palisades, New York 10964; Lindsay, E.I., Department of Geology, University of California, Los Angeles 90007; Johnson, N.M., Department of Geology, University of California, Los Angeles, California 90007

One hundred and twenty sites were sampled through a stratigraphically controlled section of mammal bearing poorly indurated clays and fine silts. The magnetically oriented samples were analyzed and it was found that a 500 oersteds peak field for its

Eleven complete reversals were identified in the section which contains fossils of the Pliocene. On the basis of the correlation of this section with the previously studied section in the Arizona, the observed magnetic polarity sequence represents the time from the mid-Pliocene to the upper Matuyama reversed polarity zone, represented by 4500 feet of section for this part of the sequence

PALEOHYDROLOGY OF A CARBONIFEROUS POINT BAR MOROCCO

Padgett, Guy V., Department of Geological Engineering and Science, Columbia, S.C., 29208

Point bar accretion scars exposed in the paleohydrology of these deposits in a paleo-drainage basin. Gently dipping, capped of overlying siltstone and shale surface for several kilometers. The surface is partially eroded, removing the high point bar, resulting in a series of shallow ridges. Radii of the ridges were measured from aerial photographs. The meander wavelength thus generated was measured and measured overall thickness of the point bar was calculated. A geographic plot of the mosaic for this late paleozoic sed