

artificially prepared greigite except that the peak at about  $26^\circ 2\theta$  was not as intense. Three strong peaks indicating spacings of 2.95, 2.46, and 1.74 Å are present and weaker peaks indicated spacings of 3.46, 1.90, 1.28, and 1.007 Å. These values agree with those given by Skinner, Erd, and Grimaldi (1964). No other phases are present in amounts detectable by this method.

Although X-ray-amorphous hydrated iron sulfide is found commonly in thin layers and small grains in Lake Superior sediments, greigite is the only crystalline iron sulfide that has been identified. *Eh* values of these sediments range from zero to +300 mv (Callender, 1969; Nussmann, 1965). Berner (1969) describes the formation of iron sulfides in reducing micro-environments around pieces of decaying organic matter. The greigite in Lake Superior sediments probably formed in this way.

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#### OCCURRENCE OF TESCHEMACHERITE IN A GEOTHERMAL WELL AT BROADLANDS, NEW ZEALAND

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#### ABSTRACT

Teschemacherite,  $\text{NH}_4\text{HCO}_3$ , occurs at the wellhead of a drillhole where it forms by reaction between gases separating from deep geothermal waters.

Teschemacherite, ammonium bicarbonate, was deposited inside the wellhead of the Broadlands geothermal drillhole BR 9 after the bore had been shut for several weeks.

The crystals, white and up to 4 mm long, were identified by X-ray diffraction and infra-red spectroscopy. The deposit, which filled the 198 mm diameter pipe to an estimated depth of about 0.5 m, was ejected in a block, "like a champagne cork," when the bore was opened. Gas pressure at the wellhead prior to discharge was 51.0 bars, the temperature was ambient, and the water level in the bore was about 490 m below ground surface.

The teschemacherite apparently formed from reaction between  $\text{CO}_2$  and  $\text{NH}_3$ , which collect at the wellhead after separating from deeper waters, as represented by:  $\text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4\text{HCO}_3$ . The gas content of water discharged when BR 9 was opened has been calculated as 0.22 mole percent of which 93.5 mole percent was  $\text{CO}_2$  (Browne and Ellis, 1970) and the total  $\text{NH}_3$  content of the discharged waters was 5.5 ppm (Mahon and Finlayson, 1972).

Teschemacherite has not been reported from other geothermal fields but occurs in some guano deposits (Palache *et al.*, 1951). Cores from drillhole BR 9 were examined for the ammonium feldspar, budding-tonite (Erd *et al.*, 1964) but none was detected.

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A SIMPLE HEATING STAGE FOR SINGLE-CRYSTAL  
DIFFRACTION STUDIES UP TO 1000°C

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## ABSTRACT

An inexpensive heating stage for single-crystal X-ray diffraction studies up to 1000° has been developed. The furnace is capable of maintaining temperatures from 20° to 1000°C to within  $\pm 10^\circ\text{C}$  indefinitely.