Title

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Author

Hebert, Alvin J.

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Alvin J. Hebert

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Alvin J. Hebert
Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

ABSTRACT

Field studies on geothermal areas in Nevada indicate that the measured sulfide levels in natural waters may help establish the source reservoir temperature. A plot of sulfide levels versus pH values for natural springs provides a technique for detecting cold springs with a hot reservoir or source.

A previously described non-dispersive soft X-ray fluorescence spectrometer[1] has been used to determine sulfide levels in natural waters.[2] A modification of the original technique has allowed a factor of five improvement in reproducibility. The technique is applicable when the waters contain species other than sulfides, (such as sulfate), which do not produce observable interferences.

Experiments are performed with a highly homogeneous group of simultaneously silver plated copper disks which have been punched from the same sheet of copper foil. Prior to use the disks are stored together in a plastic bag along with those to be used for calibration in the lab at the end of collecting each series.

The disks are brought into contact with the water as shown in Figure 1. After several hours or days under actual field conditions, the aqueous sulfide level decreases by orders of magnitude. The water is weighed and may be used to calibrate the analysis or to check for the effects of other species with respect to a distilled water calibration. Calibration disks are obtained by spiking distilled water samples with aliquots of a saturated solution of hydrogen sulfide in distilled water, and introducing a silver disk for one day.

A typical calibration line is shown in Figure 2 along with a plot of Fournier-Truesdell geothermometer[3] (Na, K, Ca) temperatures calculated for the natural waters. A relative color scale is also indicated. It appears that when a hot spring has a flowrate of a few liters per minute or more, and if the water has not boiled or bubbled, good agreement with observed downwell or Na, K, Ca geothermometer temperature calculations are obtained. Boiling or bubbling causes outgassing and lowered sulfide levels in most cases. It also appears that a set of calibration point disks could be made and used for semi-quantitative sulfide determinations by visual comparisons. This would eliminate the need for soft X-ray fluorescence analysis. The term "equivalent H_2S" in the Figures is defined as all sulfur species in natural waters that react with silver.

Sensitivities for color-tone comparison experiments are expected to be of the order of 0.1 ppm at the 0.2 ppm level and a few ppm at the 10 ppm level. The use of multiple disks would maintain good sensitivity where the sulfide levels exceed 10 ppm.

Figure 3 shows a plot of sulfide levels versus pH. Although the data appear scattered, it is important to note that all cold springs, as determined by Na, K, Ca geothermometer, plot in the pH 7 to 7.6 range with sulfide levels at less than 0.2 ppm equivalent H_2S.

Both Figure 2 and Figure 3 indicate that the sulfide levels and the pH of natural springs may be of value in assessing the geothermal potential of an area.

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FIGURE CAPTIONS

Fig. 1. Method for field monitoring H_2S and sulfide levels in waters. A water sample is placed in the Nalgene bottle and a silver disk is suspended in the water with a slotted lucite rod attached to the bottle cap.

Fig. 2. Observed sulfur X-ray intensities versus equivalent H_2S and versus the Fournier-Truesdell (Na, K, Ca) geothermometer temperature or downwell temperature reading.

Fig. 3. A plot of pH versus equivalent H_2S (ppm) for several North-Central Nevada springs.

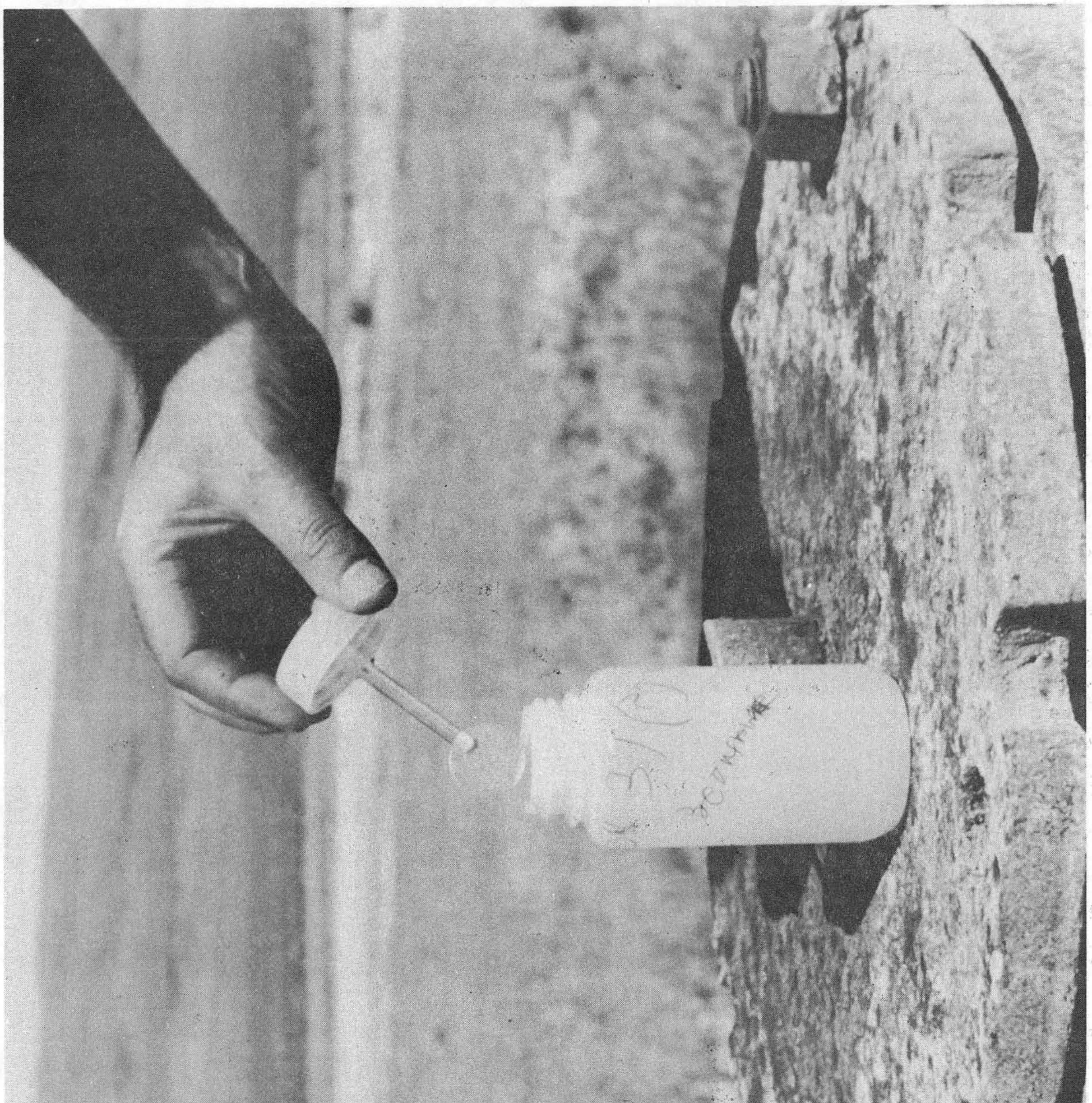
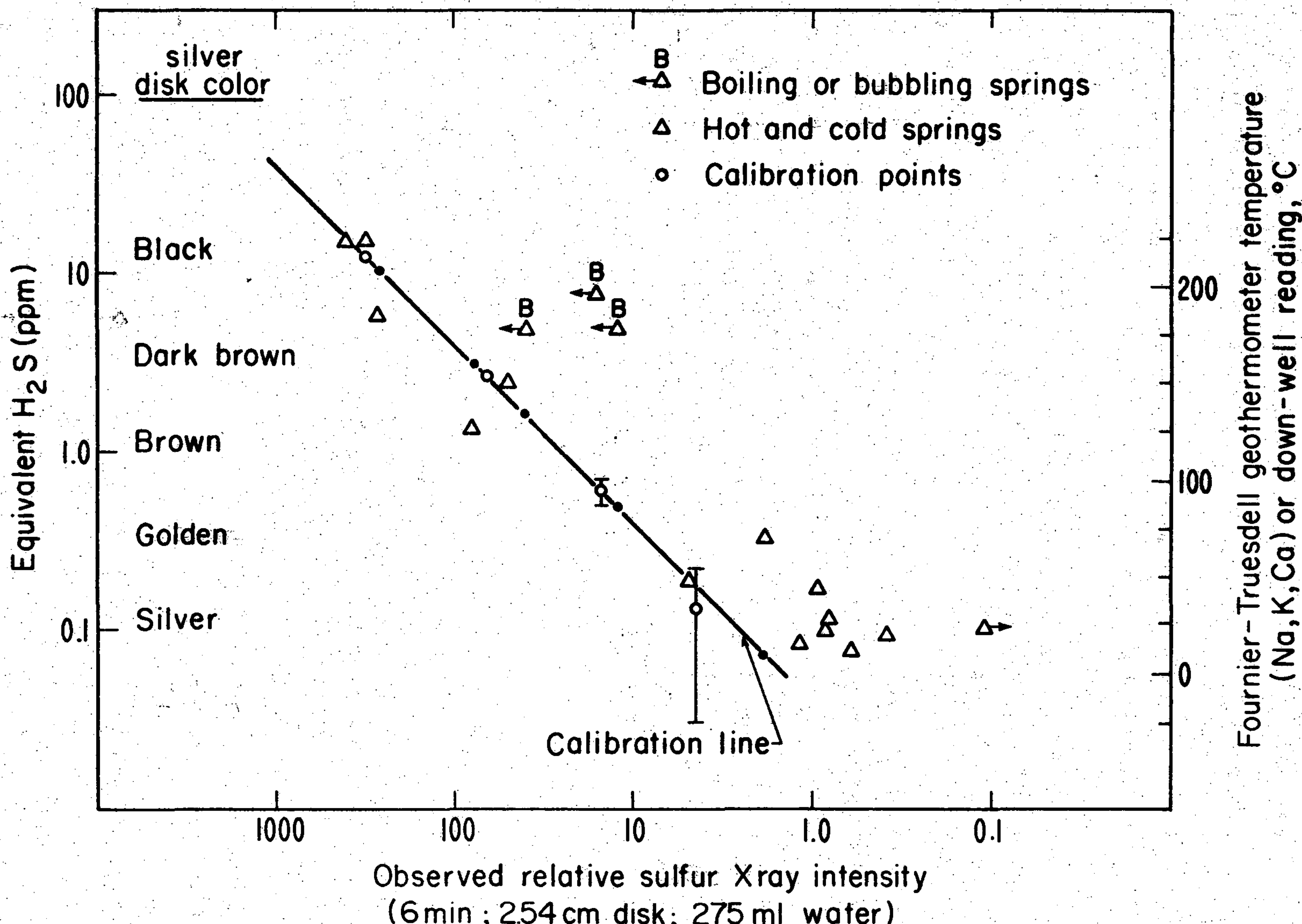


Fig. 1

CBB 748-5750



XBL 763-2527

Fig. 2

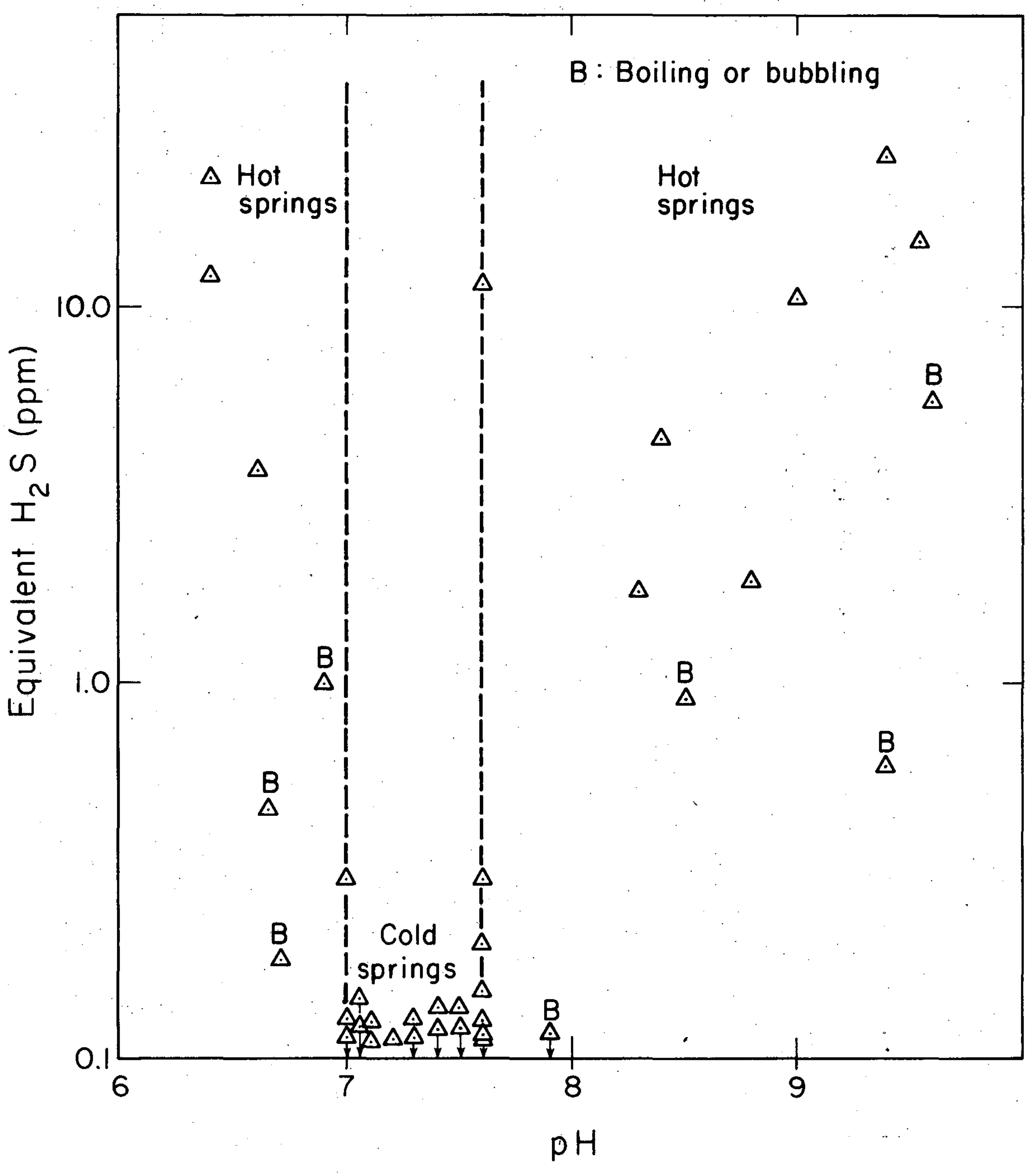

B : Boiling or bubbling
Hot springs
Hot springs
Cold springs
B
Equivalent H_2S (ppm)
10.0
1.0
0.1
6
7
8
9
pH
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Fig. 3

TECHNICAL INFORMATION DIVISION
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720