A SIMPLE HIGH-TEMPERATURE MICROSCOPE HEATING STAGE*

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In the course of geothermometric investigations in the Geochemistry and Petrology Laboratory of the U. S. Geological Survey, a microscope-mounted heating stage capable of producing moderate to high operating temperatures has been constructed. The heating stage, designed primarily for the study of fluid inclusions by the visual or Sorby method, is equally applicable for studies of melting point, phase transition, and other studies that require microscope mounted heating chambers.

The stage (Figs. 1 and 2) is built almost entirely of Marinite, a light heat-insulating material, composed of a mixture of diatomaceous earth and asbestos that can be fabricated with hand or machine tools. The only metal used in the construction, other than legs, bolts, and heating element, is a thin circular plate that gives added strength to the upper assembly of the stage. The upper assembly, which contains the heating chamber, is held above the lower support block by three metal legs. This lower block rests on the microscope stage and is held in place by a circular projection that fits the opening provided for the microscope's removable ring plate. The heating element consists of two flat coils of No. 20 nichrome wire, spaced approximately $\frac{3}{16}$ in. apart in the top and bottom of the heating chamber. Total length of resistance wire used is 12 in. The heating chamber, $\frac{3}{4}$ in. inside diameter by $\frac{1}{4}$ in. deep, has a sloping edge along part of its periphery to facilitate placing the specimen. A cover of the same insulating material, grooved for a thin silica-glass or mica window and lined with aluminum foil, fits snugly over the upper assembly. The window in the cover is kept as small as the microscope objective permits.

The temperature in the cell is controlled by a variable transformer with an input of 6.3 volts supplied by a small stepdown transformer off a 110-volt circuit. At 500° C., the upper limit of the stage for prolonged studies, the power consumption is 20 watts. For short periods temperatures as high as 700° C. may be attained by removing the stepdown transformer. Such high temperatures, however, will decrease the life of the heating element and discolor the enclosing material.

The specimen to be studied, usually a small polished mineral plate, is placed between the coils of the heating element, either on a thin quartz plate, which rests directly on the lower coil, or on a wire support. The

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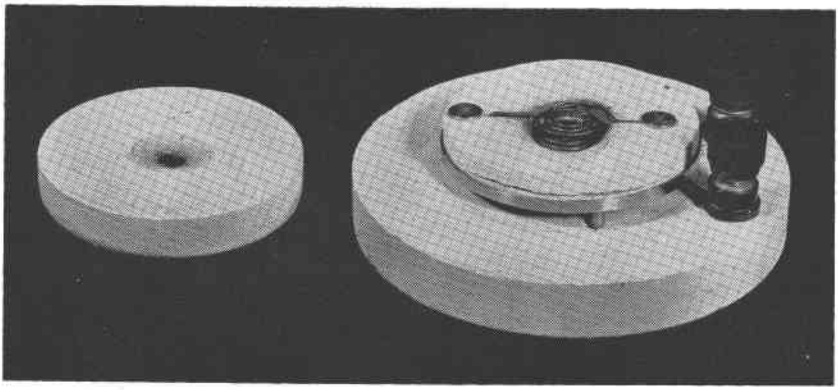

FIG. 1. High-temperature microscope heating stage with cover removed. One half actual size.

specimen is centered with the cover removed before heating has started. Temperatures are measured by a chromel-alumel thermocouple connected to a potentiometer. The thermocouple, which has a thin flat tip, is inserted through a small hole in the side of the chamber and for accurate measurement should make contact with the top or bottom of the mineral plate. For low magnification an ordinary microscope objective is satisfactory; for higher magnification objectives with larger working distances such as those adapted for use with the universal stage, should be used.

For efficient operation and wide application over large temperature ranges the basic requirements of a heating stage are: (1) uniformity of temperature within the heating chamber, (2) minimum conduction and transmission of heat from the chamber, and (3) simple but sturdy construction.

Use of the instrument described here has shown that these requirements have been adequately fulfilled. Convection effects in the chamber are practically negligible at low to moderate temperatures. At 600° C. a temperature variation of only $\pm 10°$ C. could be detected within the entire heating chamber. The relatively small but all-important region occupied by the mineral plate, however, has at most a variation of 1 or 2° C. The excellent insulating properties of Marinite (conductivity at 800° F. = 0.82 Btu/hr. ft. °F.; and low heat transmission) and the unconventional manner of placing the heating element in the heating chamber minimize radiant-heat problems.

We wish to express our thanks to Clarence S. Ross and David M. Lee, of the U. S. Geological Survey, for their contributions toward the design of this heating stage.

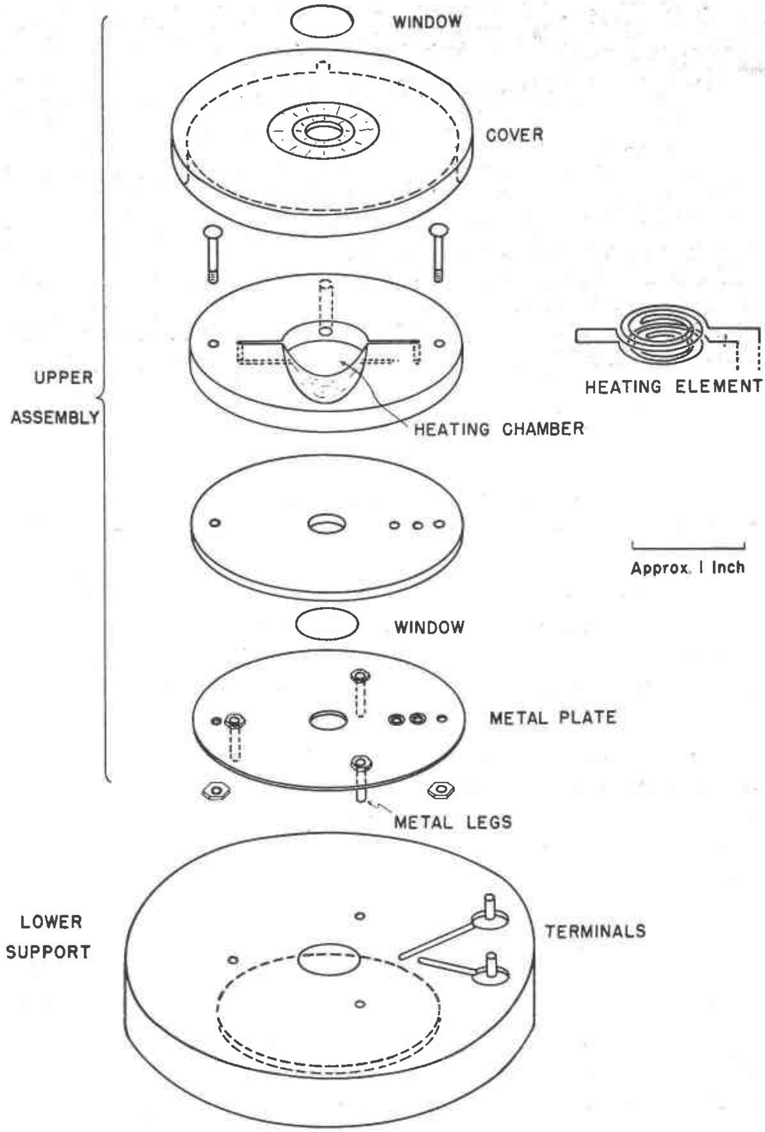

FIG. 2. Exploded isometric diagram of the high-temperature microscope heating stage. Hidden lines are shown only where necessary.