

covite at temperatures less than 100° C. in an authigenic environment, it would appear that unusual conditions must prevail. These conditions must be such as to cause a reduction in the temperature of reactions of metamorphism and dehydration by favoring the higher grade or dehydrated assemblages.

The favoring of relatively dehydrated mineral assemblages at temperatures below the usual region of stability can be caused by a low activity of water, *i.e.* a high concentration of dissolved materials in the fluid phase associated with the mineral assemblages. Normally close to unity during progressive metamorphism of water-rich sediments, the activity of water in the fluid phase in a euxinic environment, where decaying organisms and general reducing conditions may cause considerable hydrogen sulfide, ammonia, methane and other materials to dissolve in the fluid, may be reduced considerably.

A low activity of water could perhaps lower the temperature range of the chlorite + muscovite = biotite series of reactions sufficiently to bring it into the authigenic range, thus explaining the possible development of biotite in sediments before metamorphism.

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THE PREPARATION OF SMALL POWDER SAMPLES FROM THIN AND POLISHED SECTIONS

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The x-ray powder diffraction method is a valuable tool for the identification of minerals in thin and polished sections. Many methods have been employed to extract the small powder samples, the most common being the use of modified dental or micropercussion drills, or of diamond- or carbide-tipped pencils. Although these techniques are suitable for

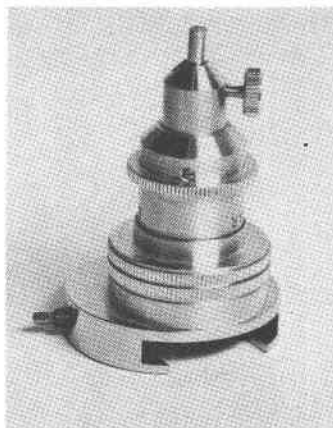


FIG. 1. Leitz object marker and centering objective mount.

many purposes, they have been found unsatisfactory for extracting inclusions with a diameter of 0.1 mm or less. Dental drills scatter the samples widely and are difficult to control, micropercussion drills have little success with harder minerals, and diamond- and carbide-tipped pencils are commonly rather bulky so that they obscure the grain, and contamination is thus difficult to avoid. Each of these methods is also difficult to use with any but the lowest magnifications, because of the lack of free working distance between the section and moderate or high power objectives.

Most of these difficulties can be overcome by using a Leitz object marker, fitted to a Leitz Dialux microscope, for drilling of the powder sample. The sample source can be located with precision, contamination from adjacent minerals is minimized, and the risk of sample loss from rare and minute grains is greatly reduced.

The object marker consists of a diamond set in a spring loaded mount having a single centering screw; the whole mount can be rotated about the axis of the microscope (Fig. 1). It is attached to the microscope by means of an ordinary objective collar, which itself can be centered in the normal way.

The marker was designed to inscribe circles around objects of interest in a microscope slide, and the single centering screw controls the diameter of the circle. In the case of the marker supplied by Messrs. Leitz to the author, it is possible, by adjusting this screw, to reduce the diameter of the circle virtually to zero, *i.e.*, the diamond rotates around its point.

In practice, the use of the marker is simple. It is centered in a collar initially by centering an ordinary objective, then unscrewing it from its

collar and replacing it with the object marker. Only slight adjustments, by a process of trial and error, are then required to complete the centering with precision. The centering of the mount is tested by scribing a circle on a microscope slide and ensuring that the eyepiece crosshairs appear in the center of the circle when the objective to be used during the sample preparation is attached to the microscope.

A series of circles is then scribed, with successive adjustments of the centering screw on the diamond mount, until the diameter of the circle is reduced to zero.

The grain to be sampled is then brought under the cross-hairs using the centered objective. The object marker is replaced and the stage is racked carefully up (or the barrel down) until the loading spring is under compression. The optimum compression should be determined by trial, and is generally related to the hardness of the mineral concerned.

The marker is then rotated in its mount by hand. Rather than complete rotation, it has been found more satisfactory to rotate backwards and forwards through an arc of approximately 60° . This seems to facilitate the drilling effect, and it also minimizes errors due to slightly imperfect centering. The number of rotations required again varies with the mineral being sampled, but twenty or thirty rapid to-and-fro movements generally suffice.

The stage is then racked down until the diamond is clear of the section, and the objective is replaced. Inspection will show if there has been any contamination (at least in the surface plane of the section). The powder is found neatly piled at the side of the drilled pit. It is then picked up with the tip of a needle dipped in clear nail varnish, and rolled into a small ball which can be mounted on the tip of a capillary and x-rayed in the usual manner.

Using this method enough powder has been successfully extracted from grains of sulfides down to 0.05 mm in diameter to produce satisfactory powder photographs. Even smaller grains can be drilled, but contamination becomes difficult to avoid, and the small quantities of powder produced require long exposures and yield spotty photographs.

The Leitz object marker is not completely satisfactory for this method. It could be improved considerably by more precise mounting of a more carefully chosen diamond, and by the provision of a more sensitive centering device. It should not prove difficult to construct an instrument for this purpose to suit other microscopes; it should be noted that it is not absolutely essential to have a rotating mount, since the stage of the microscope can be rotated instead. Spring loading is important, however, as otherwise the section shatters for some distance around the indentation when load is applied.