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NOTES ON USE AND MAINTENANCE OF VERTICAL PULVERIZERS FOR GEOLOGIC MATERIALS

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Introduction

A manual of operating instructions for the 6-inch vertical Bico* ceramic pulverizer apparently does not exist and we are not attempting to write such a manual. As our laboratory in Denver has developed and used this machine under both optimum and a variety of sub-optimum conditions for the past 20 years, we consider this report is a start toward such a manual. We discuss proper and improper techniques in using this pulverizer, which can make for success or failure in its operation. We believe this report timely for users in geochemical laboratories both in this country and abroad. The manufacturers of ceramic pulverizers should be encouraged to write a complete "Manual of Operating Instructions," especially because learning by trial and error is expensive.

The Denver grinding laboratories of the U.S. Geological Survey use alumina ceramic plates almost exclusively to avoid contamination of the ground rock sample by iron and the minor elements found in steel. The 6-inch Bico pulverizer we use for this purpose is shown in figure 1, which includes an extra set of unassembled ceramic plates: the upper plate is shown on the left and the lower plate is shown on the right, the latter when operational is connected to the vertical shaft. These plates are banded before use with metallic aluminum bands (as can be seen on the assembled plates in fig. 1), to help prevent the plates from cracking, chipping and breaking. The stationary upper plate has a band approximately 11/16 inch wide around it. This band should not be placed too high up on the plate or it will prevent proper seating on the machine. The band of the lower plate is a 1-inch rim, like the side of a dish, with an opening cut out for the vertical shaft to which the plate is attached. Both plates are available, properly banded, from the Bico Company.

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*Use of a specific brand name does not necessarily constitute endorsement of the product by the U.S. Geological Survey.

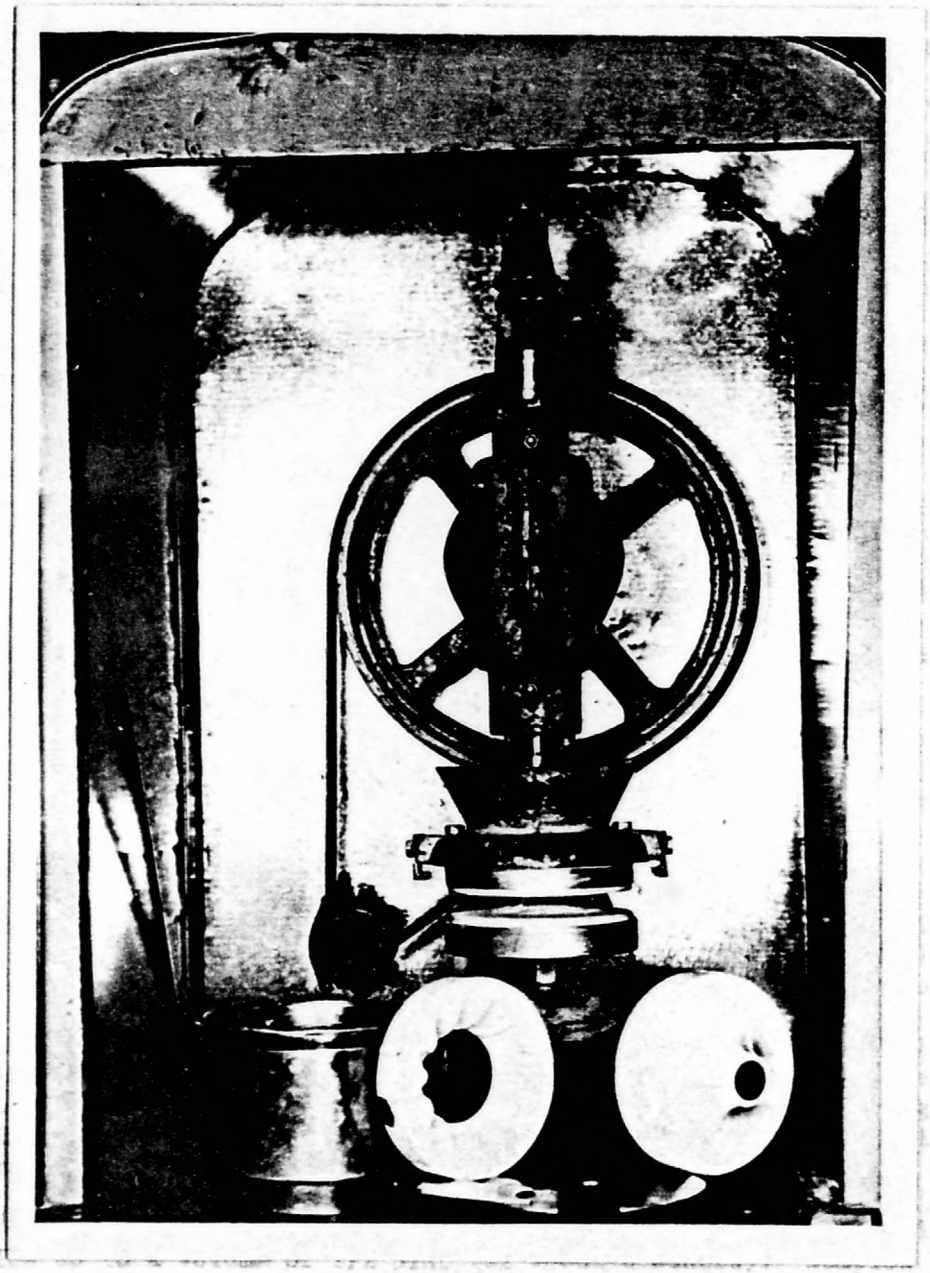

Figure 1.--Bico ceramic pulverizer with set of ceramic plates attached. Second set of plates in foreground.

Problems encountered in machine operation and maintenance

In order to get best results in pulverizing rock and other geologic samples with a pulverizer such as the vertical Bico pulverizer, it is essential to observe good mechanical operating practices. One should first get acquainted with the machine itself and study in particular the plate-setting controls before starting. It must be realized that any machine can be badly damaged unless its limitations are well known, and taken into account. When operating correctly the vertical revolving shaft with the lower plate attached turns counterclockwise. One machine was found to run backwards, resulting in a very inefficient pulverizer.

It is extremely important to check this type of machine to determine if the gear box is greased or needs greasing before the machine is put in operation. On the other hand, some new machines are supplied with permanent lubrication so that grease fittings are not required. Older models of this pulverizer, however, are normally fitted with grease zerks or cups (two zerks are on the horizontal shaft and one zerk is on the vertical shaft). A nonmetallic grease, rather than a grease containing Li, Pb, Zn, Mo, etc., should be used to avoid contamination. Those machines having grease fittings should be greased frequently, even while running, but overgreasing must be avoided again to prevent contamination of sample. Older model machines lacking a grease seal at the bottom of the gear box may need one installed.

We find a speed of 350-400 rpm for the pulverizer gives best grinding results, with less wear and tear on the machine and plates. Since there has been much confusion recently regarding the proper speed of rotation, this was determined experimentally in our laboratory. When greater speeds were used, breakage of plates and poor grinding resulted.

After pulverizing several hundred samples a slight ridge will appear on the outer edges of both the stationary and revolving plates thereby not allowing the plates to fit together closely enough to pulverize the sample to the required fineness. This malfunction can be remedied by removing the ridges with a carborundum grinding wheel. One should make sure the carborundum wheel is water-cooled. The life of the ceramic plates has been materially lengthened by use of the grinding wheel to remove ridges as they appear. The ceramic plates will last for several thousand samples when these ridges are so removed.

The Bico ceramic pulverizer has sufficient capacity to handle samples up to a volume of 1/2 pint (or about 8 ounces). Samples larger than 1/2 pint in bulk should be pulverized with an 8-inch horizontal pulverizer with ceramic plates which is designed to handle a larger volume of sample. Also no less than about 1 ounce of sample should be ground in the 6-inch vertical pulverizer. When the sample is smaller than about 1 ounce, we use other pulverizing methods.

The sample must be properly prepared before pulverizing, by crushing to pea size (1/4 inch) or smaller, by a suitable type jaw-crusher. If sample is still too coarse, try a second pass through the crusher. The smaller the rock fragments, the less wear and tear on the pulverizer, especially the ceramic grinding plates.

After the sample is crushed to a suitable size and the banded plates are attached, the next step is to carefully adjust the plate positions to pulverize the sample. By adjusting the distance between the plates, the sample is pulverized to the mesh size or grind desired. The adjusting is done with an adjusting screw on the top of the pulverizer, which is shown at the top of the machine in figure 1. It is best to hold the adjusting screw with a wrench in one hand while slowly turning the lower and upper adjusting nuts with the other hand. The pulverizer should be running during this adjustment. If the plates are adjusted too tightly together, chipping or breakage of the plates will occur. It cannot be stated too strongly that the operator must proceed slowly to avoid damage to plates, and adjusting the plates properly is the most important and difficult part of the pulverizing operation. When the plates are properly adjusted, they will be rubbing together very slightly. On soft samples like soils, sandstones, etc., one pass through the pulverizer should give a product mostly less than 100 mesh. Many hard rock samples will likely require two passes through the machine or a readjustment of the plates to give the required fineness to meet the analytical laboratory requirement. Two passes through the machine for a given rock is greatly preferred rather than setting the plates too close.

The operator should not expect that a setting which is appropriate for one rock type will be appropriate for all rock types. Rocks having special physical properties may require somewhat different settings in order to obtain a certain mesh size. It may therefore be necessary to make one adjustment for soils and soft rocks, and a different adjustment for hard rocks.

Screening samples after preparation and grinding is not a part of our routine operation as it can be an additional source of sample contamination. Samples not intended for analyses are pulverized and screened at intervals to make certain the machine is pulverizing efficiently. After one has pulverized a reasonable number of samples with an occasional screen test, it is possible to see or feel that the sample has been ground to the desired fineness.

It is necessary to clean the pulverizer hopper and grinding plates before grinding each sample to avoid contamination. When a series of samples are of roughly the same mineralogical composition, the use of compressed-air for cleaning between samples will generally be sufficient. However, if the samples are of widely different composition, then it is necessary to run clean quartz sand (about 20 mesh) through the

pulverizer, followed by compressed air to complete the cleaning before Proceeding to the next sample. When grinding samples rich in minerals that tend to smear on the plates, such as galena or molybdenite or even iron oxides, significant amounts of these minerals may be left behind on the grinding plates to be added as a contaminant to the next sample or samples processed. In these circumstances, before proceeding to the next sample, two or three successive grindings of quartz sand, each cleaned out with compressed air, may be needed to remove the contaminating mineral.

At the bottom of the Bico vertical pulverizer, covering the ceramic plate section, is an "ore pan" that catches the pulverized sample. This pan is made of aluminum to avoid contamination from iron or brass or the elements found in solder or welding rods. Carelessness in removing this pan and replacing it on the machine may introduce metal. Also careless operation may allow the revolving plate to scrape the pan, thus adding aluminum to the sample. An inexperienced operator should practice removing and replacing the pan when the machine is not running. Then, with the machine running, he should again practice removal and replacement of the pan, without scraping the rotating plate during the grinding procedure.

Samples that are unsuited for pulverizing by ceramic plates

Some types of geologic materials should not be pulverized with ceramic plates. Two examples are (1) oil shales containing a high percentage of oil or asphaltic materials, and (2) rock samples containing appreciable amounts of garnets or corundum.

The oil shales tend to "gum up" the plates causing severe chattering of the machine. It is hard on the plates and generally bad for the machine. A "hammer mill" or micro-sample mill should be used.

Trouble has been experienced when rocks containing garnets are crushed and fed into the pulverizer, the rounded garnets fall to the grinding surface where they roll around and bounce back into the hopper. If by chance one garnet does feed onto the grinding surface of the plates, the hardness and sharpness of the garnet edges tend to groove the ceramic plates.

Some types of clays are also difficult to process through the ceramic grinder. For these, it may help to adjust the plates for slightly greater than normal separation.

The normal plate adjustment or setting used for most rocks may not be suitable for some types of clay samples. In our experience increasing the gap between the plates has proven most effective for this type of sample.

Summary

The main rules for successful use of the vertical pulverizer are:

1. Know your machine.

2. Crush rock sample to pea size (1/4 inch) or smaller, before pulverizing.

3. Carefully and slowly adjust the ceramic plates to proper clearance before grinding, to obtain a pulverized product of 100 mesh.

4. Grind edges off of plates as they appear, with a suitable carborundum grinding wheel, in order to prolong plate life.