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Cavitation as a Means of Cleaning Silt Grains

By DONALD L. BIGGS

INTRODUCTION

Microscopic examination of silt grains from soils shows them to be coated with a brown, clay-like film that makes mineral identification difficult or impossible. Minerals like zircon, tourmaline, rutile and other heavy minerals are less affected by the coating than are feldspar and quartz. This latter pair make up the largest fraction of the silt and the inability to distinguish between them rapidly and easily is important. Washing with distilled water and dispersion with sodium metaphosphate failed to remove the brown coating from the silt grains. It was decided to attempt removal of the coating by ultrasonic cleaning. The instrument chosen was a Bendix UC-4 ultrasonic cleaner.

THE INSTRUMENT AND PROCEDURE

The Bendix UC-4 ultrasonic cleaner consists of an electronic generator and a magnetostrictive transducer. The generator is connected to the normal plant source, 117 volt, 60 cycle a.c. current. The frequency is increased in the generator to the sixteen to eighteen kilocycle range and is supplied to the transducer. The transducer is a rod of magnetostrictive metal of such a length that its natural resonant frequency is within the frequency range of the generator. It is surrounded by a magnetic coil that is connected to the generator output. The magnetostrictive bar is connected to the bottom of the treatment cup of approximately one quart capacity.

Reversal of current in the coil causes the magnetostrictive rod to change length. The change of length is slight, a few microns per unit length; but the high frequency of the current is sufficient to generate enough acoustical energy to fully irradiate the fluid in the treatment cup. If a liquid is irradiated by ultrasonic energy, zones of compression and rarefaction are set up that actually disrupt the fluid. This process, called cavitation, produces a non-selective scrubbing action on all surface of solids in contact with the liquid.

In this examination silt fractions from five soil samples were examined. Four ten-gram aliquots from each silt were weighed into one hundred ml. test tube and mixed with fifty ml. of water. One such ten-gram portion from each sample was exposed to cavitation

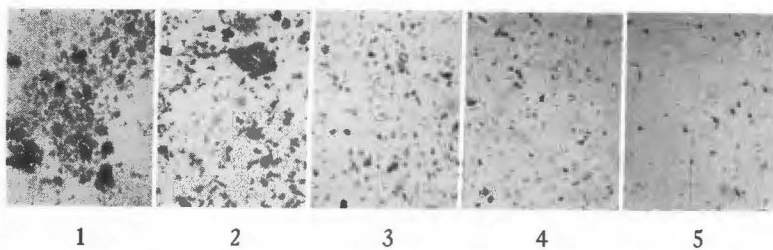


Figure 1. Silt grains before cavitation. plane polarized light 100X

A sample before cavitation is composed of about eighty percent coated grains and twenty percent uncoated grains. Some organic matter is present.

Figure 2. Silt grains cavitated five minutes. plane polarized light 100X

The silt shown in figure 2 has approximately sixty percent to the grains coated. The organic matter has been destroyed.

Figure 3. Silt grains cavitated ten minutes. plane polarized light 100X

The silt shown in figure 3 has approximately forty percent of the grains coated.

Figure 4. Silt grains cavitated fifteen minutes. plane polarized light 100X

Only ten percent of the grains shown in figure 4 are coated. This amount of coated grains seems to be the minimum obtainable under the conditions of the experiment. Figure 5 indicates little improvement despite an additional five minutes of treatment.

Figure 5. Silt grains cavitated twenty minutes. plane polarized light 100X

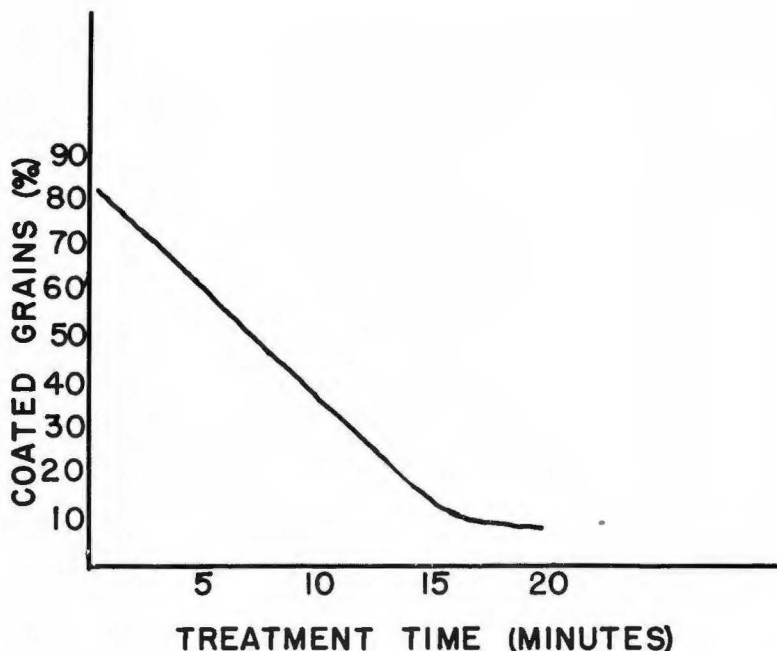


Figure 6. Variation of coated grains with time of cavitation based on 10 g. silt, 50 ml. H_2O .

for five, ten, fifteen and twenty minutes. The samples were then decanted and dried in the oven. The grains were mounted in canada balsam.

Microscopic comparison of untreated grains with those treated for five, ten, fifteen or twenty minutes shows that the cleaning proceeds at an almost constant rate for the first ten to fifteen minutes.

The percentage of coated grains was estimated by counting five hundred grains of each sample from each cavitation interval. The average decrease in coated grains for all samples is shown in figure 6.

SUMMARY

Treatment times of fifteen to twenty minutes are observed to be sufficient to assure maximum cleaning of ten-gram samples. The technique is simple, rapid and effective. The cleaning achieved, while not perfect, is satisfactory in that it enables a much closer evaluation of the quartz-feldspar ratio than is possible without it.

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