CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 64-43

THE EFFECT OF BULK DENSITY IN THE DETERMINATION OF OXYGEN BY NEUTRON ACTIVATION ANALYSIS

by

C. McMAHON

MINERAL SCIENCES DIVISION

COPY NO.

MAY 4, 1964

Mines Branch Investigation Report IR 64-43

THE EFFECT OF BULK DENSITY IN THE DETERMINATION OF OXYGEN BY NEUTRON ACTIVATION ANALYSIS

by

C. McMAHON

- - - -

SUMMARY OF RESULTS

An empirical evaluation has been made of the effect of bulk density in the determination of oxygen by fast Neutron activation. The data show that a correction factor has to be applied to the results when the weights of the standard and the unknown samples differ by more than a few grams.

---

* Senior Technician, Physics and Radiotracer Subdivision, Mineral Sciences Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

INTRODUCTION

Neutron activation analysis provides a rapid non-destructive method for the determination of oxygen in organic or inorganic matrixes. The method is based upon the fast neutron (14 MeV) reaction.

$$O - 16 + n = N - 16 + p$$

The nitrogen-16 thus formed decays with a half-life of 7.31 seconds, by the emission of high-energy (5MeV-6MeV) gamma radiation. The experimental technique involves the fast neutron irradiation of the unknown sample for 40 seconds, followed by the transfer of the sample, by a pneumatic system, to the scintillation detector where the nitrogen-16 gamma activity is counted for a period of 40 seconds.

This sequence is then repeated with a standard of known oxygen content. A comparison of the nitrogen-16 activity induced in the unknown to that of the standard gives a measure of the oxygen content of the unknown (1). Although the gamma radiation emitted in the decay of nitrogen-16 is very penetrating, some self-absorption can occur within the sample. Therefore, if the standard and unknown are of markedly differing densities, the differing degrees of self-absorption will lead to an error in the estimation of the oxygen content of the unknown.

TEST PROCEDURE AND RESULTS

In order to investigate the importance of the effect of density, a series of eight oxygen-containing samples of differing densities was prepared. Commercially available 7 ml polythene capsules were filled with firmly packed sample powder, weighed, and the lids of the capsules heat sealed. The samples were then cycled 4 times to determine the oxygen content, using an oxalic acid sample as a standard. The oxygen content of each sample was then calculated with reference to the oxalic acid standard. A comparison of the calculated oxygen content of the samples, with their known oxygen content, indicated that the heavier samples had an apparent oxygen content less than was known to be present. This is shown in Figure 1 where the ratio of measured oxygen content to known oxygen content is plotted as a function of sample weight. An effectively linear relationship exists, indicating that when the unknown and standard differ by more than a few grams, a small correction factor has to be applied to correct for the nitrogen-16 gamma attenuation.

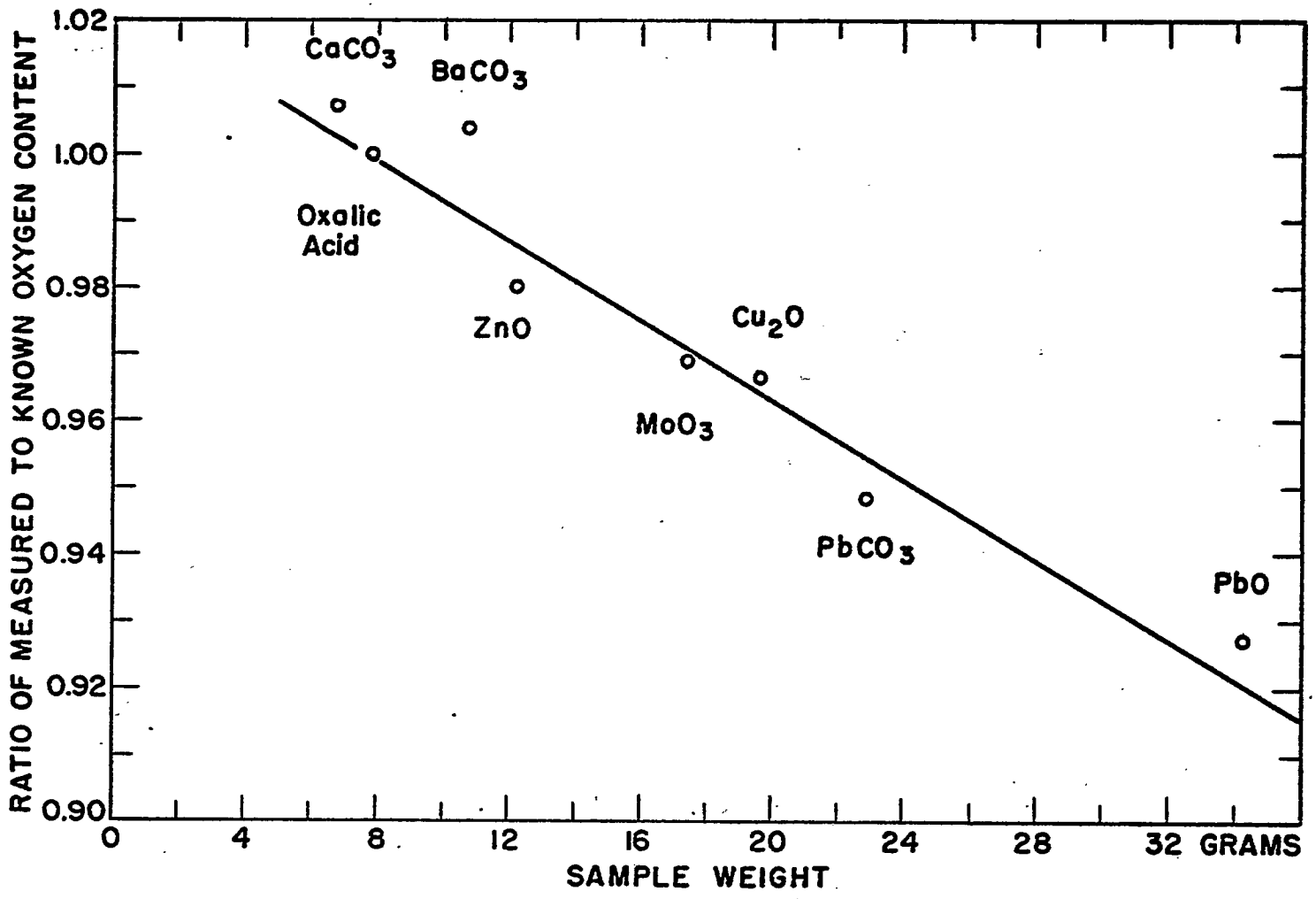

FIGURE I. RELATIONSHIP BETWEEN SAMPLE WEIGHT AND MEASURED OXYGEN CONTENT.

ACKNOWLEDGEMENTS

The writer expresses his appreciation to Dr. H.P. Dibbs who gave guidance during the investigation.

REFERENCES

(1)"The Determination of Oxygen by Fast Neutron Activation Analysis", Dibbs, H.P., Mines Branch Tech. Bull. TB-55 (1964).

C.McM:ST