JOURNAL GEOLOGICAL SOCIETY OF INDIA
Vol. 32, Oct. 1988, pp. 351 to 353

NEUTRON ACTIVATION ANALYSIS OF BAUXITES, USING AN ISOTOPIC SOURCE

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Abstract

The efficiency of neutron activation using a 5 Ci ^{241}Am-Be neutron source as an analytical technique for bauxite analysis has been evaluated. The method based on fast neutron irradiation is suggested for the determination of Al, Si and Fe employing the reactions ^{27}Al (n,p) ^{27}Mg, ^{28}Si (n,p) ^{28}Al and ^{56}Fe (n,p) ^{56}Mn respectively. Resultant γ-activity was counted on a NaI (Tl) detector coupled with single channel analyzer. The results were found to be in fair agreement with those from conventional wet analysis.

Introduction

Newly developed physical methods such as X-ray fluorescence (XRF) and non-destructive nuclear techniques such as neutron scattering (Borsaru *et al.* 1983) are fast replacing the old chemical procedures. Neutron activation analysis (NAA) has now become a well-established method for exploration studies (Amiel, 1981; Kussi, 1969; Gijbels, 1973; De Weisse *et al.* 1978). In recent years, on Stream Analyzers, using low flux isotopic neutron sources have gained importance in bulk analysis (Borsaru *et al.* 1983), process control, mineralogical processes, precious metal concentrates and loss on ignition studies. Because of their portable nature, simplicity of installation, easy handling, low price and negligible recurring expenditure, such sources are being widely used for rapid analyses (Garg and Batra, 1986). Eventhough the neutron flux obtained from an isotopic source is quite low (10^4 – 10^8 n cm^{-2} s^{-1}) as compared to reactor flux of 10^{12} – 10^{18} n cm^{-2} s^{-1}, they offer many advantages and less radiation hazards. These sources have been widely used for the determination of several elements.

In the present communication, we describe a method of determination of Al, Si and Fe in Indian bauxites using an ^{241}Am-Be source which may be suitably modified as automatic analyzer for mineral exploration studies. The results have been compared with chemical analysis data available from Mineral Exploration Corporation Ltd., India.

Experimental Procedure

Bauxite samples analyzed in this study were from West Coast (Maharashtra) and collected by MECL. Samples ($\sim$ 150 mesh) were dried at $\sim$90°C for 24 hrs. About 1 g of bauxite was packed in a wax paper bag and irradiated in a 5 Ci ^{241}Am-Be neutron Howitzer (ECIL, Hyderabad). The samples were placed on a Cd tray made from 0.5 mm thick sheet to cut off thermal neutrons. Experimental parameters are the same as described in our earlier papers (Batra and Garg, 1986). Characteristic γ-activity of the respective nuclides ^{27}Mg, ^{28}Al and ^{56}Mn was counted on photopeak position using a well type scintillation detector coupled with single channel analyzer. For Si determination, a cyclic method was adopted where sample was reirradiated after the cycle of irradiation, delay and counting is over. This is to increase the accuracy of results. Three replicate analyses were performed using

0016 – 7622/88/32-4-351/$ 1.00

different weights and mean values were calculated. The accuracy of the methods was checked by using an USGS rock BCR-1. local rock TKT-1 or pure SiO_2 as standards. In present studies, however, two of the samples with known results were used as standards so as to keep identical matrix.

Results and Discussion

The resultant radionuclides of Al, Si and Fe were identified by their characteristic γ-ray spectra and half life measurements. In Figs. 1, 2 and 3 are shown the

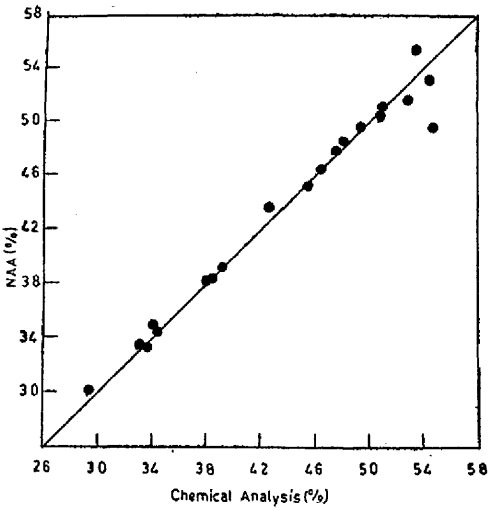

Figure 1. Comparison of the determination of Al_2O_3 by neutron activation analysis with chemical analysis

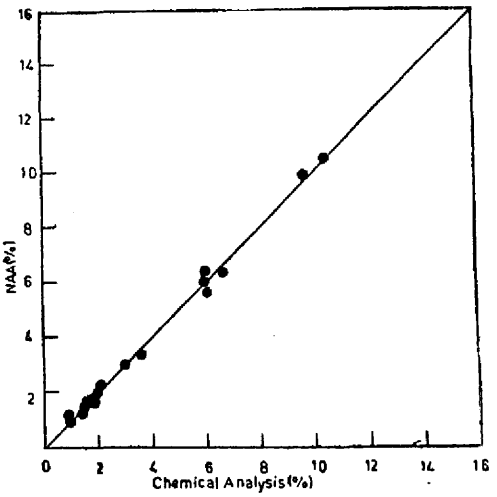

Figure 2. Comparison of the determination of SiO_2 by neutron activation analysis with chemical analysis.

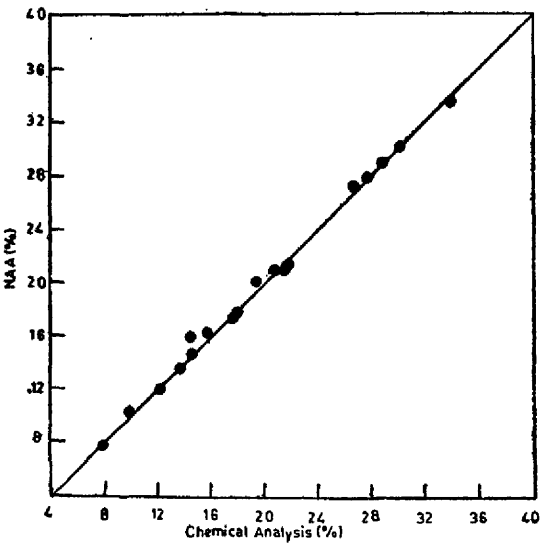

Figure 3.
Comparison of the determination of Fe_2O_3 by neutron activation analysis with chemical analysis.

correlations of our results for Al_2O_3, SiO_2 and Fe_2O_3 by NAA with those of chemical analyses reported by MECL. Majority of points fit the linear correlation with small deviation in a few cases only, proving reasonable agreement over a wide concentration range for all the three elements. Standard deviations obtained from replicate analyses using different weights were found to be Al_2O_3, 0.06–0.67; SiO_2, 0.01–0.39 and Fe_2O_3, 0.03–0.34. Standard deviations for single determination based on counting statistics were found to be less than 2.4% for Al_2O_3; 2.0% for SiO_2 and 3.0% for Fe_2O_3. Precision mainly depends on counting statistics and other factors such as electronic instability, time measuring uncertainty etc. These have been reduced by repeated measurements and averaging the results. On the basis of large number of analyses, overall accuracy of our results is $\pm$ 3% Al_2O_3 in the range 30–50%, $\pm$ 1% SiO_2 in the range 1–10% and $\pm$ 4% Fe_2O_3 in the range 10–35%. Thus, our results not only agree reasonably well but are accurate within $< 5\%$ error for all the elements. Here it is to be noted that accuracy of our results depends on the reliability of analysis of standards which is an important aspect in NAA using comparator method.

While applying this method for exploration studies, moisture content, sample size or sample inhomogeneity, change of background radiation, natural radioactivity of samples and activation of minor and trace elements will also have to be considered (De Weisse *et al.* 1978). These could be minimized by considering similar standards or else the results are likely to be quite erroneous. If all the three elements are required to be determined simultaneously, then either use of a more intense source is recommended or an optimum irradiation time should be used.

A low intensity ^{241}Am-Be source may be useful for rapid quantitative analysis of Al, Si and Fe in bauxites.

Acknowledgements: We are grateful to UGC, New Delhi for financial assistance. One of the author (RJB) thanks CSIR, New Delhi for the award of SRF. We also thank Dr. D. N. Vishnoi, Chief Mineralogist, MECL for the supply of samples used in this study.

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(Received: June 6, 1987; Revised form accepted: Jan. 6, 1988)