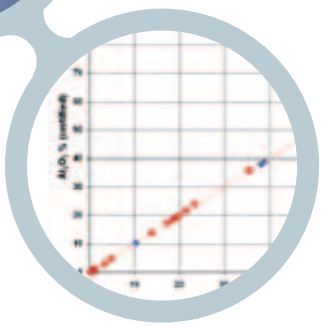
Mining process

Prepared
Bauxite sample

S8 TIGER WDXRF

GEO-QUANT M



Results

Lab Report XRF 100

S8 TIGER plus GEO-QUANT M

Grade Control of Bauxite for Aluminium and Refractory Production by XRF

Introduction

Due to its light weight aluminium is becoming more important in construction, packaging as well as in car and aircraft manufacturing. Bauxite is the most important aluminium ore and consists of several minerals. The typical grade of Bauxite useable in the Bayer process is containing 50 – 55 % Al_2O_3, a maximum concentration of 1.5 % SiO_2 and Fe_2O_3 up to 30 %. Bauxite with higher concentration of SiO_2 is typically only usable for the production of cement, abrasives, chemical and refractories. Therefore the commercial value strongly depends not only on the aluminium concentration, but on the complete elemental composition. Wavelength dispersive X-ray fluorescence (WDXRF) spectrometry is the preferred method for the monitoring of mining operations and the grade control due to the simple integration in industrial processes and the advanced analytical performance, especially for the determination of major and minor light elements. By using the fusion method for sample preparation the achievable accuracy and precision with WDXRF are far superior compared to other analytical technologies based on digestion preparation methods. Another important advantage for WDXRF is the lifetime of the calibration. Since the instrument is calibrated only once during the installation, WDXRF perfectly fits in industrial processes with a standardized quality regime. Only in maintenance intervals quick drift monitoring procedures are required while other techniques runs complete calibration sets on a daily basis. Therefore WDXRF can be run in daily routine by non analytical experts.

This lab report demonstrates the analytical performance of the WDXRF spectrometer S8 TIGER in combination with the GEO-QUANT M solution for the grade control of bauxite.

Instrument

The S8 TIGER WDXRF spectrometer comes in three different power versions 1, 3 and 4 kW. The excitation power finally determines the time-to-result and maximum sample throughput. The shortest measurement time for a given analytical precision is achieved by using 4 kW excitation power. The high intensity end window X-ray tube with Rhodium

target has a very close coupling between tube, anode and sample resulting in optimal excitation of all elements in the specimen. The S8 TIGER can be equipped with up to eight analyzer crystals and four collimators providing for each element and concentration range the best sensitivity and resolution.

Sample preparation and measurement parameters

The S8 TIGER was calibrated with the GEO-QUANT M solution. This method is dedicated for the optimum determination of major and minor elements as oxides in geological materials. It provides optimized measurement parameters for tube voltage, crystals and collimators. Based on more than 20 certified geological reference materials (CRM) GEO-QUANT M covers a wide concentration range for the elements Na, Mg, Al, Si, P, S, K, Ca, Ti, Mn and Fe. The specimens and samples were prepared as fused beads by using 0.8 g sample with 8.0 g lithium tetraborate as flux. Typically fusion furnaces are used with electrical or gas heating. Also modern furnaces with induction heating are suitable for the preparation of bauxite samples. The specific recipe of the flux and the temperature programs for different fusion models are provided with GEO-QUANT M.

The measurements for this report have been done on the S8 TIGER 4 kW. The total measurement time at peak height and background positions for 11 elements was 6.5 minutes.

Results

Five bauxite materials with certified values GBW 07178, GBW 07180, GBW 07181, GBW 07182 and BA-H have been prepared as fused beads and are used to evaluate the GEO-QUANT M calibration. Figure 1 shows the correlation of the calibration standards and the five reference materials.

The results of the accuracy test for all five samples are compared with the certified concentrations in table 1. The typical absolute deviation is less than 0.05% for minor oxides. For the major oxides Al_2O_3, SiO_2 and Fe_2O_3 the relative deviation are typically less than 0.1 %.

To demonstrate the short time stability of the method the certified standard GBW 07178 had been measured 20 times. This was also repeated 18 times for a period of 30 days to show the repeatability and reproducibility of the method and the long time stability of the S8 TIGER. Results are summarized in table 2.

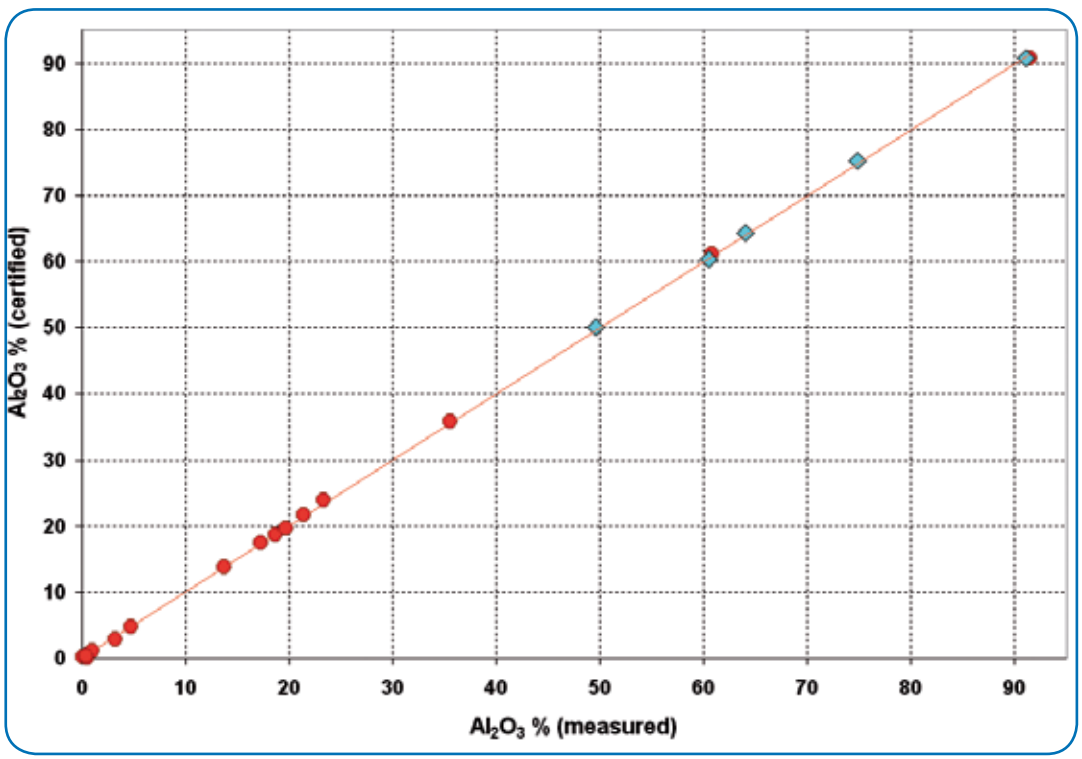


Fig. 1: Calibration curve of Al_2O_3: Calibration standards ● Evaluation samples ◆

Table 1: Results of the accuracy trial of GEO-QUANT M for five samples

	GBW 07178		GBW 07180		GBW 07181		GBW 07182		BA-H	
	Meas.	Cert.	Meas.	Cert.	Meas.	Cert.	Meas.	Cert.	Meas.	Cert.
Na_2O	0.10	0.07	0.04	0.04	0.09	0.05	0.09	0.06	0.11	0.04
MgO	0.31	0.26	0.33	0.31	0.21	0.08	0.21	0.10	0.62	0.52
Al_2O_3	54.70	54.94	42.90	42.97	91.07	90.63	74.69	75.13	50.52	50.72
SiO_2	15.18	15.24	38.56	39.03	3.60	3.20	19.22	19.44	6.46	6.63
P_2O_5	0.23	0.21	0.15	0.14	0.20	0.19	0.17	0.16	0.11	0.09
SO_3	0.16	0.11	0.05	0.07	0.03	T	0.02	T	0.21	T
K_2O	0.33	0.31	0.22	0.19	0.07	0.06	0.18	0.17	0.05	0.04
CaO	2.30	2.22	0.09	0.12	0.09	0.14	0.12	0.16	0.64	0.67
TiO_2	2.47	2.46	2.06	2.06	3.88	3.80	3.28	3.22	2.39	2.49
MnO	0.03	0.03	T	T	T	T	T	T	0.12	0.13
Fe_2O_3	8.92	9.04	0.37	0.41	1.29	1.31	1.22	1.24	22.65	22.59

Table 2: Short term precision trial for sample GBW 07178, all values shown in %
20 measurements, alternated with another sample

	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	MnO	Fe_2O_3
Certified concentrations	0.07	0.26	54.94	15.24	0.21	0.11	0.31	2.22	2.46	0.03	9.04
Average	0.10	0.31	54.70	15.17	0.23	0.17	0.33	2.31	2.47	0.03	8.93
Min.	0.08	0.31	54.60	15.10	0.23	0.16	0.33	2.30	2.46	0.03	8.92
Max.	0.10	0.31	54.78	15.22	0.24	0.17	0.33	2.31	2.47	0.03	8.94
Std. dev.	0.01	0.00	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Relative SD	5.81	0.00	0.08	0.20	1.41	1.18	0.00	0.18	0.15	0.00	0.10

Table 3: Long term precision trial for sample GBW 07178, all values shown in %
18 measurements, alternated with another sample

	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	MnO	Fe_2O_3
Certified concentrations	0.07	0.26	54.94	15.24	0.21	0.11	0.31	2.22	2.46	0.03	9.04
Average	0.09	0.31	54.62	15.20	0.23	0.17	0.33	2.31	2.47	0.03	8.92
Min.	0.08	0.30	54.56	15.15	0.23	0.17	0.33	2.30	2.46	0.03	8.89
Max.	0.10	0.31	54.70	15.23	0.24	0.18	0.33	2.31	2.47	0.03	8.99
Std. dev.	0.01	0.00	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Relative SD	6.13	1.01	0.07	0.16	1.69	2.52	0.11	0.16	0.11	0.53	0.28

Conclusion

The analysis of Bauxite for grade control is easily done in service and mining laboratories with the S8 TIGER WDXRF spectrometer using the GEO-QUANT M solution. By performing the calibration with the selected standard samples and the optimized measurement parameters the setup of the S8 TIGER is done quickly and efficiently. Valuable time and money for method development is saved.

The results of the accuracy and precision trial with certified reference materials show that the combination of both products fulfils the requirements of the industry and service labs. Relative standards deviations of better than 0.1 % for major oxides are excellent. The wide calibration range of GEO-QUANT M enables users to control a huge variety of different materials in one method. Therefore the grade control of Bauxite is done quickly, the immediate results enables a fast sorting of the different grades.

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