APPLICATION NOTE

Atomic Absorption

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Analysis of Copper in Ore using a FAST Flame Sample Automation System

Introduction

In the mining industry, one of the great challenges is knowing where to dig. In order to gain this knowledge, an area must be mapped for element(s) of interest. This is typically accomplished by drilling exploratory holes in a specific pattern, with the ore being qualitatively collected from each drill hole and analyzed for the desired elements. Due to the size of many mines, drill patterns can have a large quantity of drill holes to analyze prior to determining the quality of the ore. As a result, many samples are generated which must be analyzed to determine the viability of digging. Therefore, rapid, accurate, and repeatable analyses are required. This work discusses the analysis of copper ore samples from various drill patterns to meet these requirements.

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Experimental

Copper ore samples were prepared for analysis via a proprietary sample preparation procedure, which resulted in solutions containing 10-15% acids with dissolved solid contents up to 4000 mg/L.

The digested samples were analyzed with a PerkinElmer AAnalyst™ 400 atomic absorption spectrometer, operating in flame mode, equipped with a PerkinElmer FAST Flame 2 sample automation accessory, which consists of an SC-4 autosampler, dual peristaltic pumps, and a 1 mL sample loop. The operating conditions of the AAnalyst 400 are shown in Table 1. The FAST Flame 2 accessory allows for high sample throughput, in-line dilution, and rapid sample washout, all requirements when analyzing a large number or samples.

A geological reference material, SU-1b Nickel-Copper-Cobalt Ore (National Resources Canada, Ottawa, Ontario, Canada), was used as a QC check to monitor the accuracy and stability of the analyses. This reference material was analyzed once during an analytical run, which consisted of a calibration blank and standards, calibration verification solutions, and digested copper ore samples.

All measurements were made against external calibration curves consisting of a blank, 1, 6, 20, 30, and 40 mg/L Cu in 15% acid. All calibrations have correlation coefficients of 0.999 or better. An independent calibration verification solution (30 mg/L Cu) was run every 12 samples, and calibrations were redone after every 60 samples.

Table 1. AAnalyst 400 Operating Conditions for Cu

Parameter	Value
Wavelength	216.51 nm
Slit	1.8/1.35 mm
Burner Head	10 cm titanium
Flame/Flow Rates	Air (10.00 L/min) / Acetylene (2.50 L/min)
Lamp	Cu Hollow Cathode Lamp (Part Number N3050121)
Lamp Current	15 mA
Background Correction	Deuterium (D_2)

Results and Discussion

The SU-1b reference material contains 1.185% copper and was analyzed during analytical runs to assess the accuracy of the method. After sample preparation, the concentration of copper (Cu) being read in the reference material is 47.4 mg/L. Figure 1 shows the Cu recoveries in SU-1b from 16 separate runs over seven days, both for diluted and undiluted samples. The majority of the recoveries are within 10% of the certified value (generally accepted as showing accuracy), which demonstrate both accuracy and day-to-day stability of the methodology. In addition, because the recoveries of the diluted and undiluted samples agree, the autodilution capability of the system is proven to be robust and accurate.

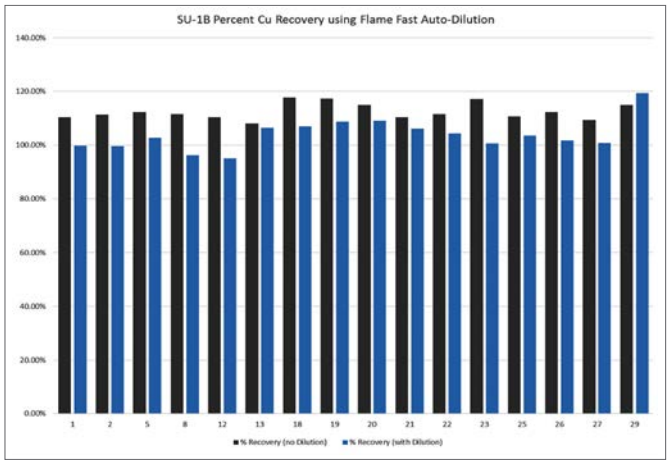

Figure 1. Copper recoveries in SU-1b from 16 runs over seven days, both with and without autodilution.

The advantage of the FAST Flame 2 accessory is increased sample throughput when using an autosampler to analyze large batches of samples, including performing in-line sample dilution. In this study, the sample-to-sample time was 28 seconds, which includes sample uptake, in-line dilution, and sample washout. With this scheme, five times as many samples were analyzed in a given time period compared with conventional sample uptake while using an autosampler.

Figure 2 shows a stability plot of the SU-1b reference material analyzed 45 consecutive times, where the recovery of each sample is normalized to the first sample. System stability is evident with deviations of 10% or less from the initial reading, with the exception of the second reading which recovered at 113% of the initial reading. For all samples, the recoveries were within 10% of the certified value.

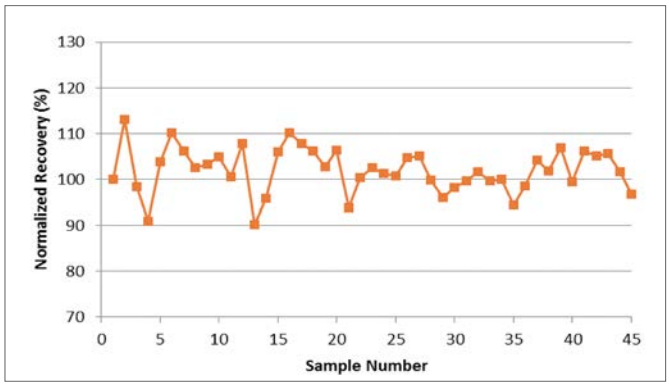

Figure 2. Stability plot for copper in SU-1b measured 45 consecutive times, with in-line dilution.

Conclusion

This work has demonstrated the ability of a FAST Flame 2 sample automation accessory coupled with an AAnalyst 400 flame atomic absorption spectrometer to rapidly and accurately analyze copper in ore samples. The FAST Flame 2 accessory doubles sample throughput when using an autosampler by providing rapid sample uptake and washout and doing in-line dilutions, eliminating the need to manually dilute samples prior to analysis. This increased sample throughput does not sacrifice accuracy or stability. The combination of FAST Flame 2 and the AAnalyst 400 has been demonstrated to be valuable for the mining industry.

Consumables

Component	Part Number
Cu Hollow Cathode Lamp (HCL)	N3050121
High Sensitivity Nebulizer	N3150188
Autosampler Tubes	B0193233 (15 mL) B0193234 (50 mL)
Peristaltic Pump Tubing (black/black)	N8145153
Copper Standard (1000 mg/L)	N9300183 (125 mL) N9300114 (500 mL)

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