Case Study

Faster and better analysis of complex samples in a geochemical laboratory

▲ Typical samples at the CGS laboratory.

The Council for Geoscience (CGS), located in Pretoria, South Africa, offers a wide range of geoscientific and analytical services. For the past fifteen years the CGS laboratory used a relatively uncomplicated traditional method for determination of the following anions: fluoride (F), chloride (Cl), nitrite (NO_2), bromide (Br), nitrate (NO_3), phosphate (PO_4), and sulphate (SO_4). They are particularly interested in examining anion concentrations in water as well as leachable anion concentrations in rock and soil samples. Their fairly rigid existing method could not handle high concentrations of Cl and SO_4 in addition to very low concentrations of NO_3 and PO_4 within the same analytical run, a typical requirement of environmental or mine water analysis. Often, samples had to be repeatedly diluted to achieve the desired analytical range. Only 45–50 samples (without dilutions) could be handled in a standard overnight run and the instrument was continually susceptible to damage from high acid or metal matrix concentrations.

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The CGS laboratory recently purchased a Thermo Scientific™ Gallery™ Plus automated discrete photometric analyzer to replace their existing equipment. This new instrument provides a huge improvement in anion analysis capability and has enabled the lab to examine additional parameters such as Hexavalent Chromium (Cr (VI)), ammonia, and cyanide. An ongoing high demand for fast, accurate analyses dictates that the new instrument must be able to handle a high sample throughput with minimal maintenance.

▲ Harold Sello and Lebogang Sathekge assisted Mandla Moyo from Anatech Instruments (Pty) Ltd in delivery of the Gallery Plus discrete analyzer.

▲ Lebogang Sathekge opening the Gallery Plus analyzer sample compartment.

The primary improvement is the ability of the new instrument to perform a discrete photometric test on each required analyte, implying that the instrument can be optimized for the specific concentration range of each individual analyte. This is in contrast to the previous method, where an average optimization setting was used for all analytes. Therefore, in one analytical run it is currently possible to determine PO_4 concentrations at low mg/L levels, while simultaneously measuring SO_4 at concentrations of 2000 mg/L or more. In addition the instrument is capable of performing analyses at an improved rate of up to 350 individual tests per hour. The instrument further offers: barcoded sample and reagent identification, automated dilutions and re-analyses, several blanking methods, automated reagent consumption monitoring, minimal waste generation, and an interface to the laboratory's LIMS software. The only requirement is that samples cannot contain any suspended, particulate material or excessive color when introduced into the instrument. Therefore, it is now standard practice to filter all natural or mine water samples in the field prior to their arrival in the laboratory.

While the instrument is capable of performing any standard photometric analysis, it was initially only to be installed at the CGS laboratory for the following two analytical series: (1) F, Cl, NO_2, NO_3, PO_4, SO_4 and Cr (VI) and (2) conductivity, pH and alkalinity.

"The CGS laboratory is now better equipped to analyze NO_3 and PO_4 at the low concentration levels required for water quality testing while also offering routine Cr (VI) analyses for the first time. This new capability therefore opens up a whole world of possibilities to the CGS laboratory for better and faster environmental analyses, drinking water quality monitoring, mine water evaluations and even several geochemical and hydrological mapping applications."

Wikus Jordaan
Wet Chemistry Section Head
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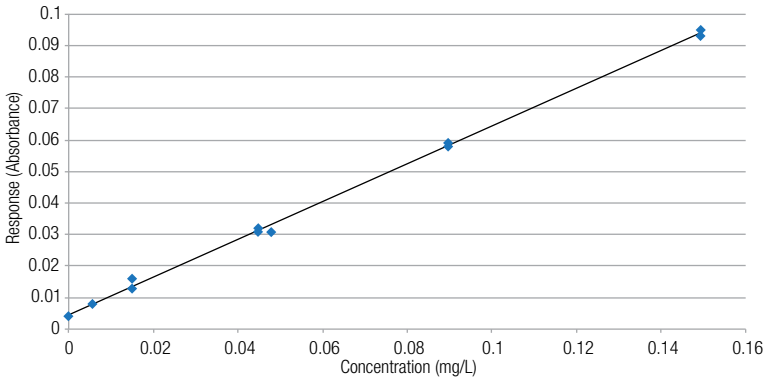
The instrument's basic principal of operation is as follows: A specific amount of liquid sample is automatically dispensed into a small cuvette. Between one and three method-specific reagents are then automatically dispensed into the same cuvette. After a timed incubation, the reagents will cause color to develop in the sample proportional to the analyte concentration. The color intensity of the sample is then measured at a specific wavelength by the instrument and converted to a concentration with the aid of a blank and a calibration standard. Quality control is achieved by means of an independent standard measured in the same manner. The instrument has the capability to automatically dilute and reanalyze a sample that has exceeded the measuring range. Electrical conductivity and pH is measured by a separate instrument module. The instrument is fully compatible with the prescriptions and regulations of the International Organization for Standardization ISO-17025 laboratory accreditation standard.

▲ Interior view of the Gallery Plus analyzer.

Calibrator/Control	Response (Absorbance)	Calculated Concentration	Given Concentration
Blank	0.004	-0.00098	0
Blank	0.004	-0.00134	0
S-CR-0.448	0.008	0.00502	0.0056
S-CR-0.448	0.008	0.00488	0.0056
S-CR-0.448	0.013	0.01424	0.01493
S-CR-0.448	0.016	0.0191	0.01493
S-CR-0.448	0.031	0.04481	0.0448
S-CR-0.448	0.032	0.04504	0.0448
S-CR-0.448	0.059	0.09002	0.0896
S-CR-0.448	0.058	0.08985	0.0896
S-CR-0.448	0.093	0.14752	0.14933
S-CR-0.448	0.095	0.15038	0.14933
QC-CR-0.448	0.031	0.04475	0.048

▲ Calibration results for Cr (VI).



▲ Calibration curve for Cr (VI).

The first attempt in the CGS laboratory at calibrating the new discrete analyzer for CrVI analyses resulted in a calibration curve with a coefficient of 0.999238. The calibration standards ranged from 5.6 to 149.3 µg/L and were analyzed in duplicate.

Several CGS laboratory staff members were trained in the operation and maintenance of the new instrument. Training involved introductory sessions presented by Mandla Moyo as well as detailed hands-on training by Vanessa Bunn, both from Anatech Instruments (Pty) Ltd. (South Africa).

In the future, the CGS laboratory will be much better equipped to analyze NO_3 and PO_4 at the low concentration levels required for water quality testing while also offering routine Cr (VI), ammonia, and cyanide analyses for the first time. This capability facilitates a new world of possibilities in the CGS laboratory for better and faster environmental analyses, drinking water quality monitoring, mine water evaluations, and even several geochemical and hydrological mapping applications.

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