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Downhole XRF-Logging: A new tool to explore borehole rock composition

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A novel type of downhole logging probe has been developed that is capable to register continuously the chemical composition of borehole walls by combining XRF techniques with downhole logging. The new tool obtains quantitatively the content of elements with atomic weights higher than that of sodium along a stripe of a borehole wall.

In mineral exploration geochemical drill core analysis is a standard to derive metal contents of an underground mineral resource. Drill core is extracted, the mineralogy of core is assessed by rapid field camp methods and sampling is performed to send samples to a lab that provides results later. In contrast wireline borehole measurements provide immediately after drilling uninterrupted geochemical results over the complete drilled section. The new XRF tool provides quantitative geochemical data along the borehole wall and can be tuned to acquire major element composition, specific metal content, or geochemical markers such as element-element ratios.

Results of a measurement campaign in dry boreholes in an Australian iron mine show a good correlation between XRF downhole probe data with laboratory results as well as with handheld XRF analyses on borehole cuttings (Fig. 1). The diagram shows as an example the correlation of the iron content measured with these different methods. The downhole probe data were acquired continuously while logging down and respectively up with a speed of 1 meter per minute. The results were averaged to increments of 2 meters to match the other measurement´s resolutions.

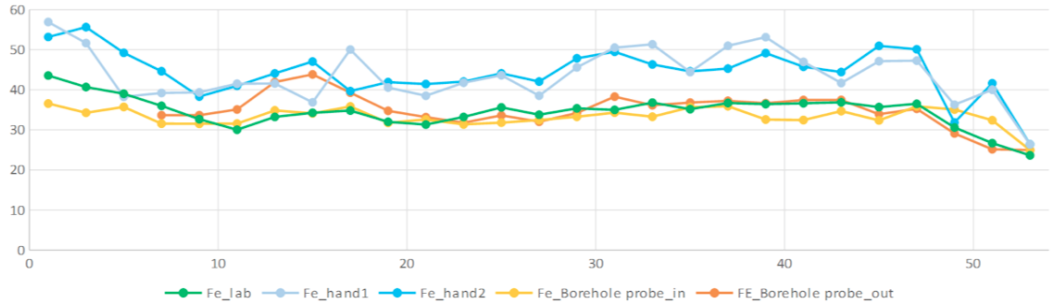

Fig. 1: Comparison of borehole probe, laboratory and hand-held XRF measurements

Measurements were taken in dry boreholes because the probe used was not certified as pressure proof at the time of the measuring campaign. For measurement in water-filled boreholes a different calibration routine has to be applied due to the dampening effect of water or borehole fluid. In each case, XRF logging requires a very short distance between the borehole wall (sample) and the x-ray source as well as the detector in order to allow most effective characteristic x-ray fluorescence radiation intake. For this purpose the probe is equipped with eccentric arms pressing the instruments x-ray window and sensors as close as possible against the borehole wall (Fig. 2).

Fig. 2: Design sketch of the