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Conservation Science

Analysis of paint samples from Emergency Swing Dam, Sault Ste. Marie Canal, Ontario

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Introduction

Three paint samples from Sault Canal Emergency Swing Dam were sent to our laboratory for analysis in order to determine the presence of any hazardous materials.

Methods of analysis

The analytical techniques for the identification of the materials present are: Fourier-Transform Infrared Spectroscopy Attenuated Total Reflectance (FTIR-ATR), Raman Spectroscopy and Scanning Electron Microscopy (SEM) coupled with Electron Dispersive X-ray Spectrometry (EDS). ATR and Raman are both vibrational techniques that are commonly used in chemistry to provide a fingerprint by which molecules can be identified. They are based on the principle that when a sample is irradiated with infrared (ATR-FTIR) or monochromatic (Raman) light, it will interact with molecular vibrations resulting in the energy of the incident beam being shifted. The shift in energy gives information about the vibrational modes in the system. The SEM/EDS technique on the contrary is based on the scanning of the sample with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the sample's surface topography (SEM) and composition (EDS).

Results and Discussion

The EDS analysis showed the presence of lead (Pb) and chromium (Cr) grains, barium (Ba) and sulphur (S) crystals, aluminum (Al), magnesium (Mg), silicon (Si) and potassium (K) inclusions, as well as titanium (Ti) and zinc (Zn). Pb and Cr comprise the pigment of basic lead chromate ($PbCrO_4 \cdot PbO$), as it was confirmed by Raman spectroscopy (Figure 1) while the aluminosilicate inclusions are in the form of albite and talc, as their presence was detected with the ATR-FTIR (Figure 2). Basic lead chromate apart from its properties as a pigment, is also used as an anticorrosive agent for steel. Clay minerals on the other hand are essential paint components since they disperse the pigment evenly throughout the paint. Barium sulphate together with titanium dioxide are typical white pigments used as additives in paint formulations possessing good white colour, high resistance to most chemicals and high refractive index (Abel 1999). As for zinc, it is most probably incorporated in the paint as a primer; zinc-rich primers with anti-corrosion properties are widely used for steel construction (Abel 1999). As far as the paint's binder is concerned, the ATR-FTIR analysis most probably indicate the presence of an epoxy and/or a polyurethane resin.

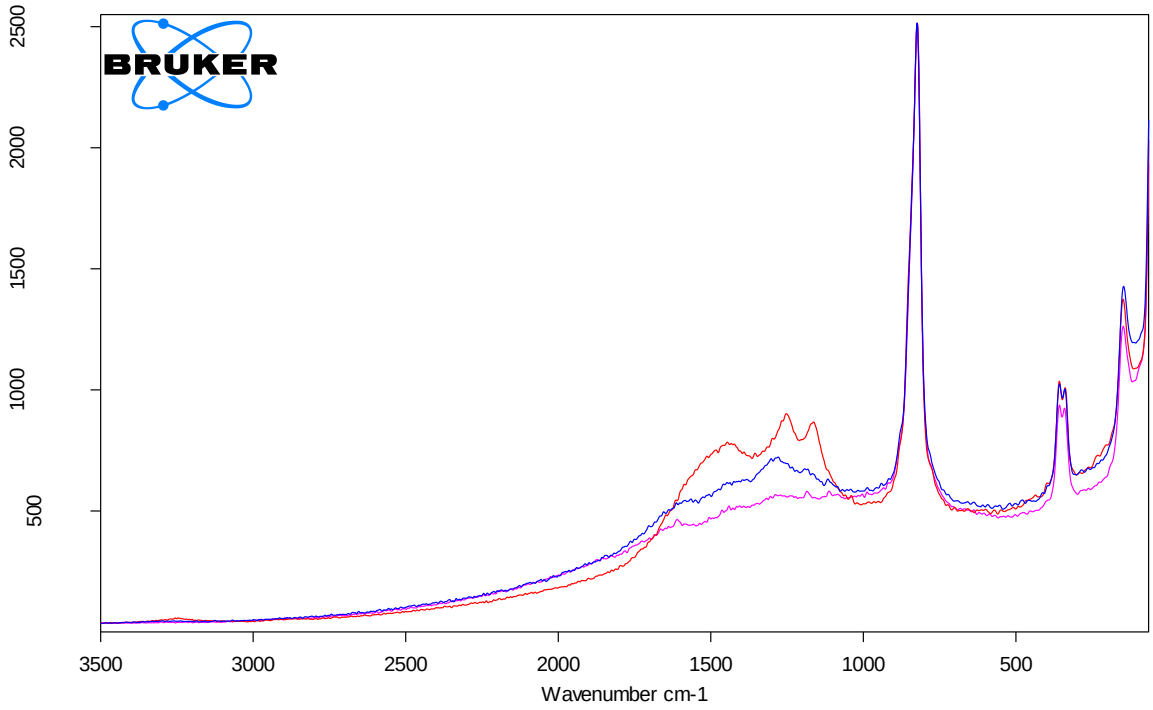

Figure 1: Raman spectra of the samples (blue: east, red: middle, pink: west) exhibiting the characteristic peaks of basic lead chromate at 824 cm^{-1}, 359 cm^{-1}, 341 cm^{-1} and 151 cm^{-1}. Peaks of the binder are also depicted.

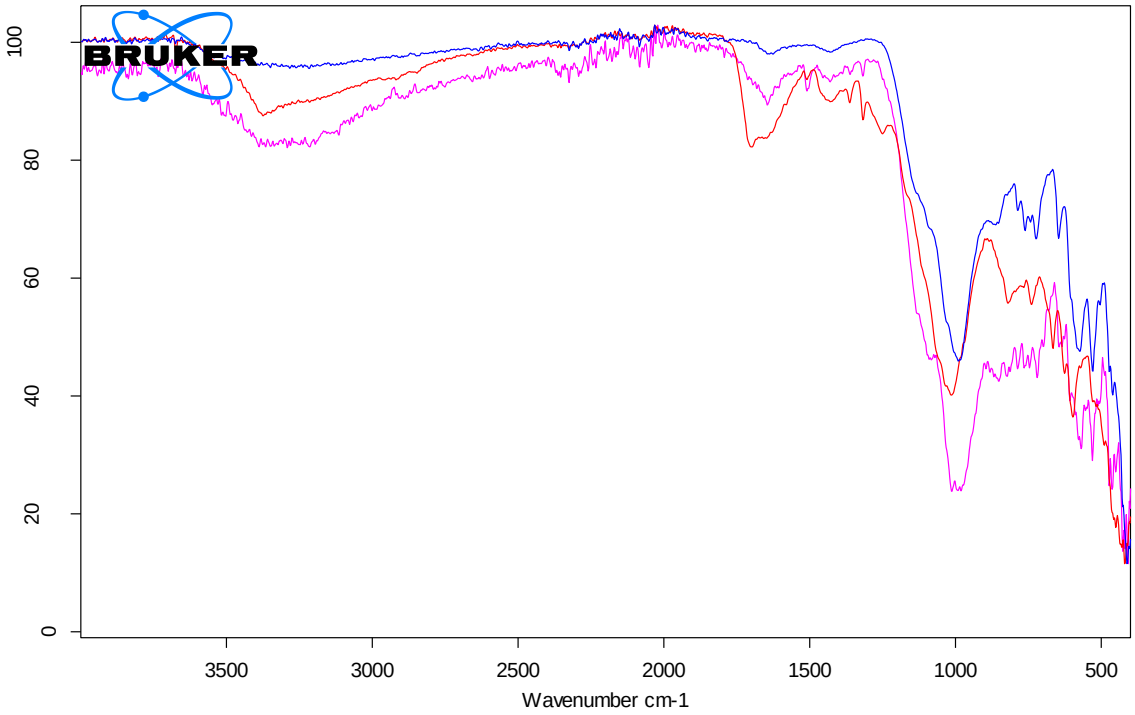

Figure 2: ATR spectra of the samples (blue: east, red: middle, pink: west) exhibiting the characteristic absorption bands of aluminosilicate minerals at approximately 1000 cm^{-1} , as well as small broad and sharp peaks attributed most probably to the paint resin.

The presence of basic lead chromate can become a health and safety issue due to the production of lead dust in case the paint deteriorates or is being removed. Chromium may cause environmental problems too, however in leaded paints it is so unlikely to become biologically available, that the discussion has been confined to lead and its impact to humans and the environment[1]. The removal of lead paint from bridges is a significant issue because of the release of lead and other contaminants in the air[2]. All waste generated must be considered hazardous and all the appropriate precautions should be taken.

References

Lambourne, R. and Strivens, T.A. eds., 1999. *Paint and surface coatings: theory and practice*. Elsevier.

[1] http://onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_265.pdf
[2] http://www.utrc2.org/sites/default/files/pubs/Final-Lead-Content.pdf