FIELD SPECTRORADIOMETRY AND ASTER IMAGERY PROCESSING FOR DETECTION AND MAPPING OF AMD-GENERATING MATERIAL OVER THE LIGNITE OPENCAST MINE OF SOKOLOV, CZECH REPUBLIC.

Stéphane Chevrel, Anne Bourguignon*, Veronika Kopaćková**, P. Rojík****

*BRGM, France, **Czech Geological Survey, ***Sokolovska Uhelná a.s., Czech Republic

1. INTRODUCTION

The paper presents the results of the last two year collaboration between BRGM and CGS (Czech Geological Survey), with the strong support of the Sokolovska Uhelná mining company. The collaboration aimed at characterising, identifying and mapping mining related environmental impacts over the Sokolov lignite mining area, with a particular focus on AMD-generating minerals.

The work consisted in laboratory and field spectroradiometry using and ASD FieldSpec 3® spectroradiometer and the processing of atmospherically corrected ASTER imagery.

2. THE SOKOLOV LIGNITE BASIN

The Sokolov Basin, Oligocene and Miocene, is between 8 and 9 km in width and 36 km in length, with a total area of approximately 200 km^2. The basin comprises 60 % volcanic ejecta resulting from faults and volcanic cones and 40 % sediment. It is bordered by a complex SW – NE faulting system. Hydrothermal fluids have been circulating along the faults where silicification and sulphur are to be found, and exposure to the latter can result in acid-mine drainage.

Lignite is found only in the western part of the basin and comprises three coal seams. The Josef coal seam represents the lower one, just over the basement rocks. It is very rich in sulphur (up to 5%) and arsenic (60 – 70 ppm). The Anežka seam is of more recent genesis than the Josef seam, and is only developed in the western part of the basin. The Josef and Anežka seams have been exploited, particularly in the Medard open pit. The Antonin seam is currently being exploited in the Jiří open pit, and contains up to 8% sulphur, together with arsenic.

The lignite is covered by a thick (120 – 150m) clay overburden, mostly kaolinitic with carbonate layers toward the top.

The area is largely affected by AMD due to the presence of sulphur, in the brown coal itself (5 to 8% pyrite in the coal) and in the hydrothermal deposits along the faulting system that borders the basin and that is affected by the exploitation.

3. METHODOLOGY

The work consisted in building spectral libraries representative of the material encountered in the Sokolov mine area. The whole stratigraphic column of the basin and its surroundings has been measured using a contact probe in artificial illumination condition. It provided a comprehensive library of spectra, free of atmospheric effects, for all regional lithologies, including AMD minerals.

Two field spectroradiometry campaigns, using a 25° IFOV fiber, have been performed on selected locations representative of the different surface features identified in the region: vegetation, clayey overburden, AMD affected areas, lignite and dumps. The second campaign (2008) provided a comprehensive library of field spectra, thanks to good weather conditions.

Simultaneous water and soil pH measurements were carried out and field sample collected for XRD analyses.

The ASTER imagery was atmospherically corrected using the ATCOR 2/3 software, performing the “in flight calibration” procedure.

Resampled to the nine VNIR – SWIR ASTER bands, the spectral libraries still present distinct absorption – reflection features that enable to identify most of minerals or lithologies of interest: kaolinite, goethite, jarosite, lignite and mineral mixtures like kaolinite/goethite or kaolinite/smectite, clay/limestone.

An image classification, using the Spectral Angle Mapper algorithm of ENVI, made it possible to accurately map theses mineral and lithologies from the ASTER imagery and a selection of best representative spectra. The results have been validated with the XRD analyses results.

4. CONCLUSION

These results are encouraging and show the ASTER capabilities in mapping AMD related secondary iron oxi-hydroxides like jarosite and goethite and to identify jarosite being present in local material mixtures, as confirmed by XRD analyses.

Field validation and better targeted field spectroradiometry measurements, taking into account present results are however still necessary, together with refined ASTER imagery processing.

A hyperspectral airborne survey is planned for 2009.