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Application of pXRF to environmental investigations and geochemical baseline of abandoned mines

We developed a method based on field measurements by portable XRF to distinguish anthropogenic anomalies resulting from mining activities, and other anthropogenic anomalies, from geogenic anomalies. It is derived from the traditional exploration strategy, based on soil and stream sediment. Instead of starting from a large and weak anomaly and focusing towards a target orebody, we start from a known mine and we observe its outwards decreasing anomaly, which includes the natural geochemical anomaly and the anthropogenic impacts. This method was applied to determine the environmental legacy of abandoned metal mines in France. Most of the differences in geochemical baselines are due to the dissimilarities in basic geology. Metals and metalloids in soils are derived from the soil parent material (lithogenic source) and from various anthropogenic sources. Transport mechanisms comprise waste erosion, airborne particles, soil creep, solifluction and surface water transport. Flood plain deposition of contaminated stream sediment and mine waste was observed and identified as one of the most extensive anomalies of anthropogenic origin.

Natural and anthropogenic anomalies can be distinguished on the basis of elemental signatures, speciation and grain size patterns. Soil anomalies need to be related with background element ranges determined for each lithofacies. Large extension anomalies are usually geogenic or related with large mines. Determination of geochemical signatures of mineralisation and of mining waste allows recognition of these signatures in soil. Anthropogenic elemental anomalies are observed in stream sediments much further away than in soils, except in flood plains.

Environmental geochemical baselines taking into account lithofacies are needed to assess the present state of the surface environment and distinguish the “natural part” from the “anthropogenic part” (mine, smelter...), to follow the extent and impact of a contamination, and to define remediation objectives.