Monitorization of the initial stages of dispersion of pollutants around municipal waste disposal facilities

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Municipal waste dumping can become a very serious environmental hazard due to leakage to the countryside of a very large array of organic and inorganic compounds caused by poor engineering or by the natural degradation with time of the confining structures. There are presently a great number of well documented cases of environmental impact caused by municipal waste dumps, but the initial stages of pollution are less well known, since interest or concern over the leaking facilities often arises only when pollution becomes very obvious and leaking has proceeded for a long time.

The work that is being conducted at the University of Lisbon has demonstrated that a combination of simple and relatively inexpensive geochemical and geophysical survey tools can give a sensitive image of the environmental situation around landfills and can demonstrate that facilities around which all environmental parameters are well below the minimum legal limits to be considered hazardous or pollutant is in fact leaking in the underground and will become, if nothing is done, a serious focus of pollution.

The studied facility is located on a fractured granite ridge in a very rainy (>1700 mm y^{-1}) hilly region of northern Portugal. The granite is a two-mica, mainly biotitic rock and is chemically fairly homogeneous over large distances. It is very heavily fractured due to several criss-crossing multi-trace shear zones, but fracture density is variable and can be as low as 1 m between adjacent fractures away from the direct influence of the shear structures. Fracture density controls weathering intensity and sometimes metassomatic alteration. Argillization is always incipient to non-existant and most fractures lack any inflilling and are thus open conduits for water.

Geochemical water, soil and sediment surveys demonstrate that chemical backgrounds are very easy to establish, and that these are constant over an area much larger than the one directly influenced by the facility. Those surveys also document that underground and surface waters collected below and around the facility are chemically slightly modified showing trace amounts of a large array of chemical elements distinctly above the regional chemical background, although most of them easily qualify as chemically potable waters by portuguese regulations. The same is true of sediments deposited by surface run-off escaping from the facility, although the range of elements now above regional background is limited to the base metals Cu, Zn and Pb, together with some less significant light transition elements. Concentrations above background decrease away from the facility in both sediment and water samples.

Geo-electric surveys across the facility have shown that it overlies several fracture zones (which show up in the profiles as vertical low resistivity zones) and a localized intense anomaly of low resistivity. Under the facility, this very anomalous domain is restricted both vertically and horizontally to a location under the main leachate collector, but it broadens horizontally away from it and seems to disappear as the ground elevation becomes lower than the lowest part of the calculated anomaly. This strongly suggests leaking and a mainly horizontal flow of the leaked liquids, this last inference supported by the obvious signs of contaminations of spring waters welling up below the lowest level of anomalous resistivity.