No. 4: Technical Note on Directional Geochemical Analyses of Dust

When considering the composition of dust, it is essential to collect dust directionally, so that the provenance of that dust is fully understood.

COMPOSITION OF DUST

DustScan Ltd routinely undertakes various studies of the chemistry of dust captured on directional sticky pads. Trials at various sites have shown that dust originating from landfill operations and other industrial activities is best analysed using standard geochemical techniques, since much of that dust does not occur in standard mineral forms. Dust from mineral operations, such as quarries, can be conveniently analysed using mineralogical techniques, but geochemical methods are equally valid in that setting.

Chemical composition of dust

To analyse dust on sticky pads it is necessary to dissolve the dust and undertake standard spectrometric analyses (ICP-AES analysis: inductively coupled plasma – atomic emission spectrometry). Using the dust collected on sticky pads involves dissolving the sticky pads and the adhesive, as well as the dust, and the ashing of a parallel sample to obtain the residual mass. It is not possible to readily remove the dust from the pads. Hence, this assists in obtaining data on the indicative mass of dust and subsequently concentration of different elements within that dust. Meaningful and useful data can be obtained to fingerprint dusts from specific sources and to explore the concentration of the discharges from various industrial sites.

The analyses undertaken rely upon dissolving the dust and the pad in strong acids. The limits of detection with standard equipment are about 10 ppb. It is necessary to initially analyse a representative section of the sticky pad and the adhesive since some contaminants occur, albeit it at relatively low levels, within these materials. This avoids errors that would otherwise arise with the same elements occurring in the dust.

Data is standardised before analysis to allow for the size of the sample being tested and the dust coverage, so as to reduce distortions that might arise due to excessive loadings of the sample with dust. In practice it is has been found that the lowest level of AAC appropriate for testing is 70% – below 70% dust levels are too small.

Samples may also be classified in three ways: (i) according to the bearing of the potential source from the sampling location, (ii) by reference to the distance from the source of the sampling location, and (iii) on visual appearance, essentially colour and texture. Clearly samples that are taken close to a potential source and down-wind of the source are more likely to reflect the chemistry of the source materials than other sampling locations; the colour and texture of the sample recovered may also give some indication as to its provenance. It should be recognised that it is difficult if not impossible to obtain truly representative chemical analyses of materials in all situations. The closer a dust is sampled to a source site the more likely it is to represent the source material.

Analyses are produced of almost all elements that are reliably handled by the ICP-AES method. At any one site a percentage of elements may be below detection levels, but are still present below those levels.

Fingerprinting of dust

Simple plots of the ratios concentrations of one element against another may indicate one or more populations of different materials originating from a single site (see Figure 1). It is often useful to obtain non-random, but reasonably representative samples of local top-soils, sub-soils and rock types, and to analyse these samples for comparison with dusts collected on sticky pads. All types of dust *etc*. may be plotted together. In doing this it is often seen that certain elements are concentrated within a specific dust and that some 'dust types' have similar characteristics. Average composition in ppb can be found for specific dust types and differences and similarities between dust types identified and correlated using standard statistical methods. For example, the chemistry of dust emanating from an industrial site can be compared with the chemistry of nearby local soils *etc*.

One standard method of assessing the composition of dust is by reference to the widely recognised standard crustal geochemical analysis of the earth's crust. Sample correlations relative to the same ratios in the earth's crust can indicate high and low levels with respect to the earth's crust. Commonly ratios of elements are calculated in relation to that of aluminium (Al). Such a ratio is known as the enrichment factor, *i.e.* enrichment factors can be determined for each element in a dust in comparison with aluminium. It is commonly found that dust from landfill sites comprises lead and other elements at significantly higher levels than in the earth's crust.

Enrichment levels can also be compared by reference to different materials. For example, it is possible to normalise dust enrichment levels with respect to those found in local soils.

Whilst it is at times appropriate to sample materials being used at an industrial site and to compare concentrations of different elements with those found in dust, it is often difficult monitor all changes. Fortunately it is not essential to have this information. Experience based on directional geochemical analyses of dust collected close to sites shows that the character of dusts may change with time, depending on the variation in the proportions and amounts of different materials being handled.

Dispersion of dust

Enrichment levels can be considered close to a potential source (say, within 50m down-wind) and at greater distances there from where enrichment levels may be lower and the chemistry of dust reflects natural background levels of the local soil *etc*. It is possible, using standard graphical display methods, to equate the maximum enrichment levels near the source to 100% and to explore the dilution of these levels with distance and location with respect to the source. By this means it is possible to establish the percentage content of critical dust at, say, a residential site by determining the percentage enrichment in terms of the maximum level. Figure 2 shows enrichment factors at an industrial site compared with that for local soils.

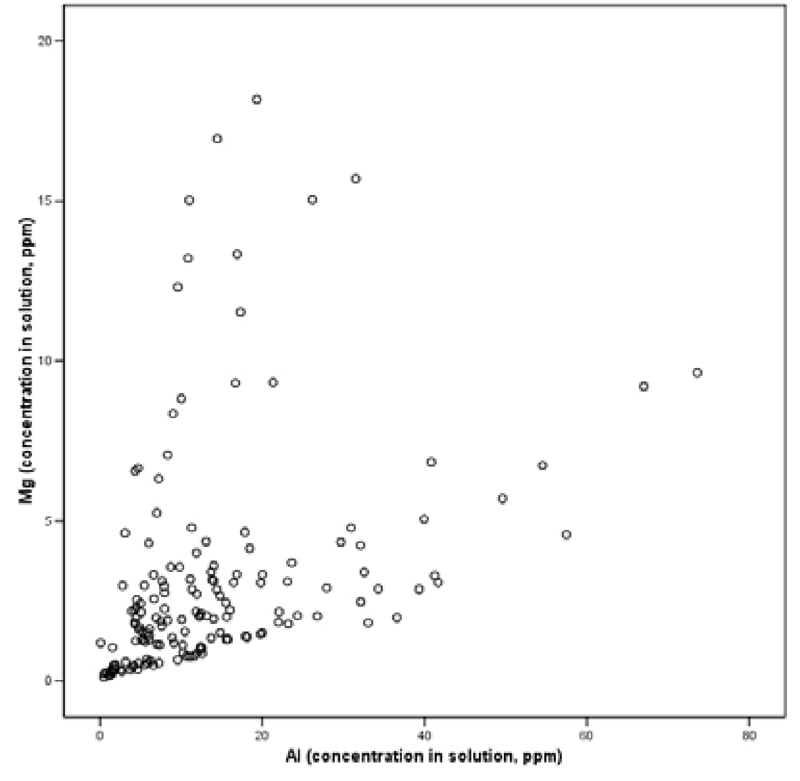

Figure 1: Dust composition trends: comparison between concentrations of Mg and Al in a range of samples indicat-

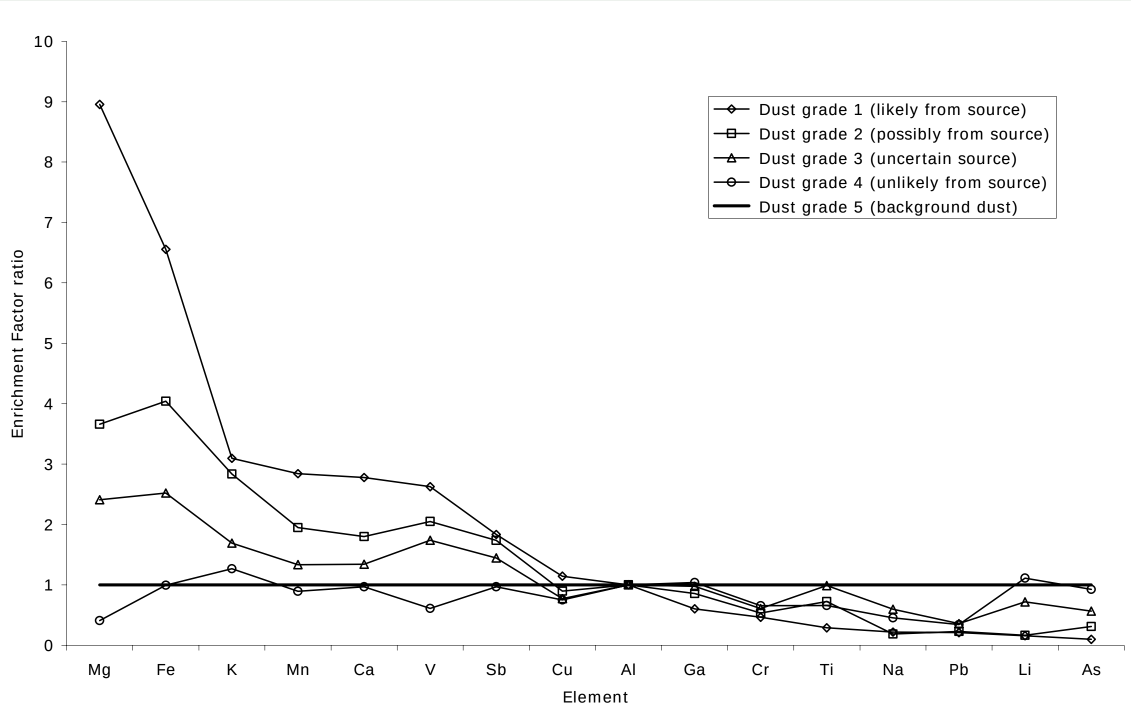

Figure 2: Linear plot showing Enrichment Factors for different elements and dust types, ordered by magnitude for Grade 1 dust and normalised to 'background' dust. This chart illustrates the transition in dust character, in terms of the concentrations of a suite of elements, from a likely source to background conditions.