Patterns in major and trace element dynamics during long-term decomposition of boreal forest litters

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Background

The dynamics of a large number of major and trace elements were examined during a series of long-term litter decomposition experiments in Swedish boreal and nemoboreal forests during the 1980s and -90s. Litterbags with leaf litters from Norway spruce (*Picea abies*), Scots Pine (*Pinus sylvestris*), Bilberry (*Vaccinium myrtillus*) and European beech (*Fagus sylvatica*) were incubated for between 4 and 8 years at sites with a wide geographic distribution in Sweden. In 2004 these samples were reutilized for multielement analysis (ICP-MS).

Multielement dynamics

Principal component analysis and manual scatter plots revealed groups of elements behaving in a similar manner during the decomposition process, although there were some differences between the needle and leaf litters. One group consisted mainly of nutrients, and had a general trend with decreasing amounts during decomposition. Another group contained mostly unessential elements, whose total amounts generally increased during the decay process. An exception from this trend was found for a few elements e.g. Cd and Hg, for which the amounts increased initially followed by a net leaching from the litter. An interesting anomaly in the bahaviour of Thallium was discovered, as the total Tl amounts in all needle litters decreased during decomposition, whereas the opposite was seen in the leaf litters. This indicates a difference in the plants uptake or translocation mechanisms, where the decidious plants are able to protect themselves from the highly toxic Tl.

Conclusions

The results indicate two distinct general trends in element behaviour during litter decompostion. There are however several subgroups or exceptions from these general patterns, e.g. slight differences between the species groups.

The fact that the samples were collected at a time of higher atmospheric metal deposition than at present, provides additional information and usefulness of the results.

Statistical evaluation of anomalous compositions in fluid geochemistry

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Outliers have been defined by Barnett and Lewis (1994) as observations characterised by their extremeness and their discordancy, being unreasonable statistically in terms of some basic model. Thus outliers have be considered in relative terms with respect to a univariate or multivariate random variable assumed as model for the population from which data have been drawn. The problem of detecting outliers in a multivariate matrix is thus equivalent to the problem of determining if all the observations can be considered as representatives of the population under study, characterised by an appropriate distribution function, or if some of them have to be considered atypical or discordant. Identification of anomalous compositions in a database results to be an important item to point out extreme compositions called end-members. Their reconnaisance allows us to evaluate the contributions of the different sources to each of the observation vectors (geochemical samples) of the data set and to understand processes affecting mixtures of fixed source compositions systems. Since geochemical data concerning composition of fumarolic gases are expressed in μmol/mol, to capture the pattern of variability of these datasets it is necessary to use adequate probability distributions (Aitchison, 1986). In this work a discussion about the use of different probability models will be presented by considering samples of fumarolic gas periodically collected at Vulcano Island (Sicily, southern Italy) in the last six years. The implications of the presence of anomalous samples will be discussed on the light of both end-member identification problems to be related to different sources and surveillance problems (monitoring programs of compositional changes). Since many systematic and random processes control the chemistry of gas discharges from active and quiescent volcanic areas, our results indicate that stochastic modelling represents one of the possible way to quantify uncertainty and to assume responsible interpretation of natural phenomena.

References

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