THE CANADIAN MINERALOGIST

Journal of the Mineralogical Association of Canada

Volume 14 February 1976 Part 1

PREFACE

The premise that man can insure survival of all life through correct management of environment entails ever-increasing effort to minimize the destructive effect of his own insatiable demands for more of everything, as an individual, and as a species "blooming" in the biological sense. Fundamental to all such management is acquisition of a sufficient supply of pertinent facts, logical interpretation of which provides basis for decision among various courses of action. Unfortunately, in resource management, the confrontation of pragmatism and idealism seldom permits unequivocal choice, and best compromise always must be sought for greatest eventual benefit. In the correct judgement of cause and effect which should precede action, realistic selection of such compromise demands scientific objectivity in interpretation. Emotional issues must be placed in their proper context, as only one of the factors taken into consideration for long-term human survival. The science of mineralogy, intensively applied in environmental studies, provides many of the facts upon which accurate judgements can be based.

Most environmental problems result from the formation of deleterious products caused by reactions involving solids. In most cases, the solids in the reaction are minerals, or minerals are indirectly involved in the reactions. More often than not, an environmental problem and the ecological consequences are incompletely or incorrectly analyzed because rigorous mineralogical studies have not been carried out. At the same time, information obtained from basic mineralogical, petrographical, and geochemical studies carried out with no environmental context can be of extreme importance to environmental problems, particularly when a "crisis approach" demands objective yet rapid opinion. Mercury in the environment is an excellent example, where non-environmental geochemical and mineralogical information could have been used by all investigators and was used by some to define preliminary reference levels relative to pollution problems. The early work of Stock & Cucuel (1934) on Hg abundances suggested a mean of about 0.1 ppm Hg in crustal rocks, with a maximum in common rocks approaching 1 ppm. But papers appeared in the literature during the early concern about Hg (for example, Joensuu 1971) suggesting that Hg occurred in coal at the 20± ppm range. A commonly-accepted value for Hg in crustal rocks is now about 0.07 ppm, with exceptional concentrations in non-economic metal deposits approaching 1 ppm. Also, another estimate of normal crustal abundances of Hg could have been extrapolated from guidelines used by geochemists in exploration for metallic ore. Minimally, Hg concentrations must exceed 0.1 ppm to reflect a metallic occurrence (Warren *et al.* 1966). Furthermore, studies of soil migration of Hg and the general geochemistry of Hg (Anon., 1970) point to the fact that it migrates in the solid phase in water bodies. Hence, focus on the solid phase is prerequisite to understanding the reactions, migration and ultimate fate of Hg.

Acid non-productive lakes occur in Canada (Beamish 1974), Scandinavia (Grahn *et al.* 1974) and the United States (Cogbill & Likens 1974). In all cases, these acid lakes are in non-calcareous igneous and metamorphic rocks. However, the key factor in the acidification process appears to depend upon the mineralogical composition of soil, unconsolidated sediment, and bedrock. The relationship between lake productivity and geology was originally interpreted by Card & Gillespie (1966) for the Sudbury, Ontario region. In the Canadian Precambrian Shield, the mineralogy of unconsolidated sediments is the most important factor in this relationship. Nevertheless, the mineralogy and geochemistry of unconsolidated sediments is not known well, since mineralogists typically do not study glacial sediments and glacial geologists do not commonly carry out mineralogical or geochemical research. Exceptions to this are recent works by Allen (1974).

The removal of pollutants in aqueous natural solutions infers an adsorption or precipitation process. Tertiary treatment of wastewaters for the removal of P involves the addition of

$Ca(OH)_2$ and the probable formation of Ca-phosphates, the addition of $FeCl_3$ and the probable formation of Fe-phosphates, and the addition of alum and the probable formation of Al-phosphates. In some wastewaters, authigenic struvite forms from the high concentrations of NH_3 and P in the waste and the naturally-occurring Mg. Pilot-plant use of natural clinoptilolite for the removal of NH_3 in wastewaters (Cohen 1972) demands more detailed mineralogical information about this zeolite, as there are variations in the NH_3 adsorption, capacity, and regeneration of the zeolite. No definitive mineralogical studies have been carried out on any of these systems.

Mineralogical and geochemical studies on the use of solid wastes for the removal of pollutants is an obvious and desirable extension to the common practice of addition of chemicals to treat wastes. In particular, kaolinite, bauxite and high-Fe^{3+} oxides and silicates appear suitable to study for P removal, and finely-ground gangues with low Al/Si ratios may be suitable for adsorption of trace metals.

In the selection of disposal areas for various types of solid and liquid waste, both organic and inorganic, the properties of the mineral phases existing within and around waste materials, and their mutual interactions under all probable conditions, must be studied to ensure minimal effect on environment during the life of the site. As an example, successful passivation against oxidation of sulfide-bearing wastes, to avoid excessive acid drainage and air pollution, and to allow stabilization by revegetation, has drawn on knowledge of individual reactivities of sulfide minerals.

Some of the papers originally presented orally at Waterloo are not included in this issue. Other papers have been solicited in order to obtain a reasonably comprehensive coverage of the environmental geochemistry and mineralogy of Sudbury, Ontario in a Canadian journal.

We appreciate the interest and assistance of the Editors of the Mineralogical Association of Canada in bringing an important aspect of geochemistry and mineralogy into print.

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Received January, 1976.