Impact Stratigraphy: Searching for a needle in the haystack of the rock record

A. MONTANARI

Osservatorio Geolgico di Coldigioco, 62020 Frontale di Apiro, Italy

There is an obvious scarcity of impact signatures (iridium anomalies, spherules, shocked minerals, etc.) known at present in the stratigraphic record, compared to the number of large craters on the surface of the Earth. Montanari et al. (1988) explained that this "*...is mainly due to the fact that the search for signatures such as Ir anomalies, spherules, and shocked minerals, has been mainly focused across those few short stratigraphic intervals where major extinctions are recorded, or which were known to cover the time of major impacts. The work of the stratigrapher searching for a millimetric impact layer in a sedimentary sequence hundreds of meters thick is comparable to the proverbial search for the needle in the haystack*". In consideration of this problem, the pelagic carbonate sequence of the Umbria-Marche Apennines of Italy appears a rare opportunity to approach the search for impact signatures in a stratigraphic and sedimentary framework that is remarkably continuous, complete, and well dated.

With this paper, I will describe the stratigraphic details of outcrops in this region, which record major biologic crises that are possibly linked to extraterrestrial events. For the particular cases of the K\T boundary and the Late Eocene, where distal impact signatures have been found, I will illustrate evidences such as geochemical anomalies, spherules, and shock metamorphosed minerals that have been found there, remarking on the differences between the two extraterrestrial events, the first probably related to a single, giant collision, and the second clearly recording multiple impacts, which are probably related to a comet shower.

For the other potentially interesting intervals, in which impact signatures have yet to be found, but which may correlate with extinction peaks and/or large known craters (in particular the Tr\J and the J\K boundaries), I will limit myself to a description of the stratigraphy commenting on the completeness and significance of the paleontologic record. The details on the search for the needle in the Umbria-Marche pelagic haystack are extensively exposed in a recent book by Montanari and Koeberl (2000). Since the publication of this book, the search of distal impact signature in the Umbria-Marche has remained frustratingly elusive. Wrong haystack or wrong needle (or both)?

References

Montanari, A., Campo Bagatin, A., and Farinella, P., 1998, Earth cratering record and impact energy flux in the last 150 Ma: Planetary and Space Science, v. 46, p.271-281.

Montanari, A., and Koeberl. C., 2000, Impact Stratigraphy: The Italian record: Lecture Notes in Earth Sciences, Springer, p. 1-364.

Surface chemistry and acidic dissolution of forsterite

TERESITA A. MORALES, ROGER HERBERT

Department of Geology and Geochemistry, Stockholm University, 106 91 Stockholm (Teresita.Morales@geo.su.se, Roger.Herbert@geo.su.se)

Introduction

Column studies with olivine sand (particle size of 0.58 mm) and other silicates were performed for the evaluation of material proposed for the neutralisation of acidic mine drainage in a field installation. The laboratory study was conducted under varied incoming concentrations of artificial AMD, pH and flow rates.

Results and discussion

Dissolution of olivine was found to be successful in neutralizing acidity, since a continuous pH buffering was obtained from pH 2-3 to pH 5-6. Compared to Si-O bonds, the Mg-O bonds are easier to break and the release of Si proceeds more slowly. In this study, at high flow rate (75 ml/h, residence time of 5.3 h) at a pH of 2.3, Mg is released at a rate of 1.83×10^{-7} mol/s, while Si is released at 3.24×10^{-8} mol/s. The rate of dissolution also shows a correlation with acidity flux. The studies indicate higher dissolution rates obtained with higher flow rates and lower pH. Mg is released at a higher rate than Si, consistent with other studies. Saturation index values (MINTEQA2) indicate the possible formation of amorphous SiO_2, which may increase with increased weathering

Electron microscopy studies and XPS data suggest that silica-rich faces have formed on the surfaces and that iron-rich precipitates at the inlet may limit continued weathering, giving lower ratios of Fe/Si, and higher Mg/Si toward the outlet, hence a relatively higher release of silicon from the surface. Higher binding energies also suggest an increase in ferric iron formation at the inlet of the column consistent with oxygen binding energies (data not shown). The XPS molar ratios are given for different levels within the column and hence for different degrees of weathering. XRD and Mössbauer measurement proved that the initial untreated olivine sand mainly consists of the end member forsterite but also some minor traces of quartz and other silicates may be present.

	Mg/Si	Fe/Si	Mg+Fe/Si	O/Si	O/Fe	pH
Ideal ratio	2	0	2	4	0	-
Untreated	1.27	0.16	1.43	3.58	22.6	-
Inlet	0.18	1.23	1.41	5.16	4.19	2.1-3.8
Outlet	0.49	0.61	1.10	4.30	7.05	5.8-6.7

Table 1. Molar ratios at olivine surface based on XPS data. The pH is given for water at the inlet and outlet of the column.