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Autor: Jarvis, Ian / Burnett, William C. / Nathan, Yaacon

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Experimental data concerning the kinetics and thermodynamics of trace-element incorporation by francolites is a prerequisite for quantitative modelling. Further experimental work, together with mathematical modelling of natural and artificial systems, are essential if the transition is to be made from empirical to theoretical studies of phosphogenesis. However, the complexities of natural phosphogenic environments should not be underestimated. It is also important to make the point that there remains a limit to which present-day phosphorites may be used as a analogues for the genesis of ancient deposits. The most notable difference is that most major phosphorites are granular while modern phosphorites are dominantly nodular. Recent studies have demonstrated that granular phosphorites are forming in modern settings and that phosphorite hardgrounds are more widespread in both the modern and ancient than previously realised (Glenn et al. 1994a, b). Nonetheless, there remains no known exact analogue for the phosphorite 'giants' of the geological record. The basic physical-chemical processes which control the precipitation of francolite and the genesis of phosphorites must have been the same in the past as they are at the present day, and there is no doubt that we have learnt much about these from our studies of modern sediments. Nonetheless, there remains the fundamental questions as to why ancient deposits are so different and what are the environmental factors that these differences reflect?

Over the last two decades, geochemical and particularly isotopic studies have led to major advances in our understanding of the genesis and diagenesis of phosphorites, but many problems remain unsolved. What is the precursor mineral to francolite in modern environments? When and how are specific trace elements incorporated in phosphorites, where are they located and what was their source? Are humic compounds or other organic complexes instrumental in these processes? To what extent do kinetic and thermodynamic factors control trace-element contents? Are trace-elements good redox indicators? Are weathering and metamorphic effects kinetically controlled; is long term-burial at modest depths equivalent to short periods of deep burial?

To answer these questions, traditional geological analyses of ancient and modern phosphorites will have to be complemented by: (1) new analytical methods to empirically determine the distribution and behaviour of trace elements and isotopes in phosphorites; (2) better integration of inorganic and organic geochemical studies; (3) multi-element and multi-phase studies to examine the relationship between francolite geochemistry and those of associated mineral phases; (4) more extensive data on the porewater and solid-phase geochemistry of modern phosphogenic and associated non-phosphogenic environments; (5) experimental work to determine the kinetic and thermodynamic factors which control apatite precipitation and the incorporation of trace elements in francolite; (6) more refined modelling of natural and experimentally derived data.

Results from these geochemical studies will continue to provide one of the best means of refining models of phosphogenesis. An understanding of geochemical processes is essential to assessing and ameliorating the environmental impact of phosphate rock extraction and processing and the use of phosphate fertilisers.

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REFERENCES

ABU MURRY, O.S. 1993: Distribution of rare earth elements in Jordanian phosphate. Concepts and Controversies in Phosphogenesis. Int. Symp. and Workshop, Matten, 6-10 September, 1993.

ALTSCHULER, Z.S. 1973: The weathering of phosphate deposits – geochemical and environmental aspects. In: Environmental Phosphates Handbook (Ed. by GRIFFITH, D., BEETON, A., SPENCER, J.M. & MITCHELL, D.T.). Wiley & Sons, New York, 33–96.

– 1980: The geochemistry of trace elements in marine phosphorites. Part I: Characteristic abundances and enrichment. In: Marine Phosphorites (Ed. by BENTOR, Y.K.). Soc. Econ. Paleont. Miner. Spec. Publ. 29, 19–30.

ALTSCHULER, Z.S., CISNEY, E.A. & BARLOW, I.H. 1952: X-ray evidence of the nature of carbonate apatite. Geol. Soc. Am. Bull. 63, 1230–1231.

ALTSCHULER, Z.S., CLARKE, R.S. & YOUNG, E.Y. 1958: Geochemistry of uranium in apatite and phosphorite. US Geol. Surv. Prof. Pap. 314-D, 45–90.

ALTSCHULER, Z.S., BERMAN, S. & CUTTITI, F. 1967: Rare earths in phosphorites – geochemistry and potential recovery. US Geol. Surv. Prof. Paper 575(B), B1–B9.

ANON 1989: Cadmium in phosphates: one part of a wider environmental problem. Phosphorus Potassium 162, 23–30.

– 1993: Phosphate Rock helps feed the world. Engineer. Min. Jour. 194, 2, 73.

ATLAS, E.L. 1975: Phosphate equilibria in seawater and interstitial waters. PhD Dissert. Oregon State University, Corvallis.

ATLAS, E.L. & PYTKOWICZ, R.M. 1977: Solubility behaviour of apatites in seawater. Limnol. Oceanogr. 22, 290–300.

AVITAL, Y., STARINSKY, A. & KOLODNY, Y. 1983: Uranium geochemistry and fission track mapping of phosphorites, Zefa Field, Israel. Econ. Geol. 78, 121–131.

BACHRA, B.N., TRAUTZ, O.R. & SIMON, S.L. 1965: The effect of magnesium and fluoride ions on the spontaneous precipitation of calcium carbonates and phosphates. Arch. Oral Biol 10, 731–738.

BACQUET, G., VO QUANG, T., BONEL, G. & VIGNOLES, M. 1980: Résonance paramagnétique électronique du centre F dans les fluorapatites carbonatées de type B. J. Solid State Chem. 33, 189–195.

BAECHLE, H.-T. & WOLSTEIN, F. 1984: Cadmium compounds in mineral fertilisers. Proc. Fertil. Soc. London 226, 1–18.

BAROLE, D.V., RAJAGOPALAN, G. & SOMAYAJULU, B.L.K. 1987: Radiometric ages of phosphorites from the west coast of India. Mar. Geol. 78, 161–165.

BATURIN, G.N. 1978: Phosphorites on the Ocean Floor (in Russian). Izdat. Nauka, Moscow.

BATURIN, K.N. & KOCHENOV, A.V. 1974: Uranium content of oceanic phosphorites (in Russian). Litologia I Poleznye Iskopaemye 1, 124–129.

BATURIN, G.N. & ORESHKIN, V.N. 1984: Behaviour of cadmium in ocean-floor bone phosphate. Geochem. Int. 35, 69–74.

BATURIN, G.N., KOCHENOV, A.V. & PETELIN, V.P 1970: Phosphorite formation on the shelf of SW Africa. Lithol. Min. Res. 3, 266–276.

BATURIN, G.N., MERKULOVA, K.I. & CHALOV, P.I. 1972: Radiometric evidence for recent formation of phosphatic nodules in marine shelf sediments. Mar. Geol. 13, M37–M41.

– 1974: Absolute dating of oceanic phosphorites by disequilibrium uranium. Geochemistry 11, 568–574.

BECKER, P. 1989: Phosphogypsum: expensive waste or profitable by-product. Phosphates and Phosphoric Acid. Marcel Dekker Inc. 537–569.

BENMORE, R.A., COLEMAN, M.L. & MCARTHUR, J.M. 1983: Origin of sedimentary francolite from its sulphur and carbon isotope composition. Nature 302, 516–518.

BENMORE, R.A., MCARTHUR, J.M. & COLEMAN, M.L. 1984: Stable isotopic composition of structural carbonate in sedimentary francolite. Spec. Publ. Geol. Surv. India 17, 35–40.