

Zeitschrift: Eclogae Geologicae Helvetiae
Herausgeber: Schweizerische Geologische Gesellschaft
Band: 87 (1994)
Heft: 3: Concepts and controversies in phosphogenesis : proceedings of the symposium and workshop held on 6-10 September 1993

Artikel: Concepts and controversies in phosphogenesis : an introduction
Autor: Föllmi, Karl B.
DOI: <https://doi.org/10.5169/seals-167473>

Nutzungsbedingungen

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

Conditions d'utilisation

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

Terms of use

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

Download PDF: 25.04.2026

ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>

Concepts and controversies in phosphogenesis – an introduction

KARL B. FÖLLMI¹

Phosphorus (in the form of phosphate) is an essential nutrient in the marine and terrestrial biosphere, known to have limiting properties in landlocked, shallow-marine environments (e. g. Bothnian Sea and eastern Mediterranean Sea; e. g. Granéli et al. 1990, Krom et al. 1991), pastoral and agricultural ecosystems (e. g. Smith 1992, Crews 1993), and freshwater communities (e. g. Caraco et al. 1989). According to many authors, phosphorus may limit bioproductivity in general, mainly because of its capability to regulate nitrogen fixation in a variety of terrestrial and aquatic ecosystems (e. g. Holland 1978, Broecker & Peng 1982, Smith 1992, Mackenzie et al. 1993, Berner et al. 1993, Filippelli & Delaney 1994; however, compare also Codispoti 1989, 1994). As such, phosphorus may be the important driving force behind photosynthetic fixation processes of carbon and oxygen. Furthermore, through the stimulation of bioproductivity, phosphorus may profoundly influence marine and terrestrial ecology through the structuring of food-web networks which are very much dependent on the amount of nutrients and rates of primary production. Through the control of export production (i. e. the amount of organic matter that is not reused within the trophic zone of production; e. g. Berger et al. 1989), phosphorus may also influence oxygen availability in areas where the exported organic matter is oxidized. All this renders phosphorus a biophile element with extensive regulating capacities with regards to climate (in forcing the transformation atmospheric CO₂ → organic carbon), oxygen content and ecology.

In the last two decades we have seen an increasing recognition of the crucial role phosphorus plays in the environment. Many aspects of the biogeochemical and environmental interactions of phosphorus, however, need further elucidation, especially in the light of the considerable anthropogenic increase in phosphorus flux rates. Bulk phosphorus flux rates have been more than doubled by human activity on a global scale (Froelich 1984, Caraco 1993), and this may be beneficial in the short term (e. g. the use of phosphorus in fertilizers), but it certainly devastating in the long term (in affecting and altering complex ecosystems such as coral reefs in tropical seas and biological communities in general in fresh-water lakes and peripheral seas; e. g. Caraco 1993). Besides this, phosphorus may already have an impact on present-day climate by compensating for approximately 10% of the annual increase in atmospheric CO₂ from anthropogenic sources (Mackenzie et al. 1993).

Observation of present-day phosphorus behaviour is our prime source of understanding, in giving invaluable information on biogeochemical transformation processes. The geological record of preserved phosphate-containing phases from various paleoenvironments adds considerably to our knowledge in giving additional information on long-term processes and interactions of phosphorus and the environment. Moreover, the geo-

¹ Geologisches Institut, ETH-Zentrum, CH-8092 Zürich

logical past may serve as a template for testing our present-day observations and interpretations in a deductive approach; for instance, through the observation and numerical modeling of temporal relations between natural fluctuations in the global phosphorus cycle, paleoclimate and paleoecological change (e. g. Compton et al. 1993, Filippelli & Delaney 1994, Van Cappellen & Ingall 1994).

One of the incentives for organizing the Symposium and workshop "Concepts and Controversies in Phosphogenesis" (Matten near Interlaken, Sept. 6–10, 1993) was to provide a possibility for scientists working in recent natural and experimental environments, scientists working in environments of the geological past, and representatives of the phosphate-exploiting industry to convene and explore the various aspects of phosphogenesis in an integrated approach, under the auspices of IGCP 325 "Correlation of palaeogeography with phosphorites and associated authigenic minerals". During the meeting, we emphasized round-table discussions, arranged for a full-day workshop, and provided ample time for discussions. The size (45) and mixture of participants from industry and research groups in the USA (7), Russia (4), Canada (1), Mexico (1), Argentina (1), Tahiti (1), India (1), Pakistan (1), Egypt (2), Jordan (5), Israel (2), Albania (1), Spain (1), Portugal (1), France (6), Germany (2), United Kingdom (2), Poland (1) and Switzerland (5) allowed for a lively and yet informal meeting. The first three days were devoted to three different themes: 1) "Phosphorus, sedimentology and paleoceanography"; 2) "Phosphorus, geochemistry, agriculture, and industry"; and 3) "Phosphorus, the microbiosphere, and interactions of phosphorus with other biophile elements". In the morning, the theme of the day received an overview in three of four introductory talks and a subsequent poster session. In the afternoon, concepts and controversies central to the theme were explored in two round-table discussions, each guided by two chairmen and one rapporteur. On the fourth day, we formed three working groups, each devoted to one of the themes. These working groups summarized their findings in three reports, which served as a base for the three review papers presented here. The working group papers were compiled with the objective to provide a synoptic, multi-authored view of the status-quo in research and industry with regard to various physical, biogeochemical, and environmental aspects of the phosphorus cycle (Jarvis et al. 1994, Krajewski et al. 1994 and Glenn et al. 1994).

A cordial thank is directed here to our sponsors, the Swiss Academy of Natural Sciences (Bern), the Swiss National Science Foundation (Bern), the UNESCO (Paris), the Municipality of Matten, the Geological Institute, ETH (Zürich) and the Geological Institute of the University Louis Pasteur (Strasbourg). The editor of the *Eclogae geol. Helv.*, Hanspeter Funk, is gratefully acknowledged for his assistance with the edition and publication of the proceedings of this meeting, and for providing German translations of the abstracts.

REFERENCES

- BERGER, W.H., SMETACEK, V.S. & WEFER, G. 1989: Ocean productivity and paleoproductivity – an overview. In: *Productivity of the ocean: present and past* (Ed. by BERGER, W.H., SMETACEK, V.S. & WEFER, G.), Report Dahlem Workshop, John Wiley, Chichester, 1–34.
- BERNER, R.A., RUTTENBERG, K.C., INGALL, E.D. & RAO, J.L. 1993: The nature of phosphorus burial in modern marine sediments. In: *Interactions of C, N, P and S biochemical cycles and global change* (Ed. by WOLLAST, R., MACKENZIE, F.T. & CHOU, L.), NATO ASI Series I4, Springer, Berlin, 365–378.
- BROECKER, W.S. & PENG, T.H. 1982: *Tracers in the sea*. Eldigio, Palisades.

- CALDEIRA, K. & RAMPINO, M.R. 1991: The Mid-Cretaceous super plume, carbon dioxide, and global warming. *Geophys. Res. Letters* 18, 987–990.
- CARACO, N.F. 1993: Disturbance of the phosphorus cycle: a case of indirect effects of human activity. *Trends Ecol. Evol.* 8/2, 51–54.
- CARACO, N.F., COLE, J.J. & LIKENS, G.E. 1989: Evidence for sulphate-controlled phosphorus release from sediments of aquatic systems. *Nature* 341, 316–318.
- CODISPOTI, L.A. 1989: Phosphorus vs. nitrogen limitation of new and export production. In: *Productivity of the ocean: present and past* (Ed. by BERGER, W.H., SMETACEK, V.S. & WEFER, G.) Report Dahlem Workshop, John Wiley, Chichester, 377–394.
- CODISPOTI, L.A. 1994: Nitrogen vs. phosphorus as controls on oceanic primary production. *Eos, Trans. Amer. Geophys. Union* 75/3, 75.
- COMPTON, J.S., HODELL, D.A., GARRIDO, J.R. & MALLINSON, D.J. 1993: Origin and age of phosphorite from the south-central Florida Platform: Relation of phosphogenesis to sea-level fluctuations and $\delta^{13}\text{C}$ excursions. *Geochim. Cosmochim. Acta* 57, 131–146.
- CREWS, T.E. 1993: Phosphorus regulation of nitrogen fixation in a traditional Mexican agroecosystem. *Biogeochemistry* 21, 141–166.
- FILIPPELLI, G.M. & DELANEY, M.L. 1994: The oceanic phosphorus cycle and continental weathering. *Paleoceanography* 9, 643–652.
- FROELICH, P.N. 1984: Interaction of the marine phosphorus and carbon cycles. *Jet Propulsion Lab. Publ., NASA* 84–21, 141–176.
- GLENN, C.R., FÖLLMI, K.B., RIGGS, S.R., BATURIN, G.N., GRIMM, K.A., TRAPPE, J., ABED, A.M., GALLI-OLIVIER, C., GARRISON, R.E., ILYIN, A., JEHL, C., ROHRICH, V., SADAQAH, R.M., SCHIDLOWSKI, M., SHELDON, R.E. & SIEGMUND, H. 1994: Phosphorus and phosphorites: Sedimentology and environments of formation. *Eclog. geol. Helv.* 87, 747–788.
- GRANÉLI, E., WALLSTRÖM, K., LARRSON, U., GRANÉLI, W. & ELMGREN, R. 1990: Nutrient limitation of primary production in the Baltic Sea. *Ambios* 19, 142–151.
- HOLLAND, H.D. 1978: *The chemistry of the atmosphere and oceans*. Wiley-Interscience, New York.
- JARVIS, I., BURNETT, W.C., NATHAN, Y., ALMBAYDIN, F., ATTIA, K.M., CASTRO, L.N., FLICOTEAUX, R., HILMY, M.E., HUSAIN, V., QUTAWNAH, A.A., SERJANI, A. & ZANIN, Y.N. 1994: Phosphorite geochemistry: State-of-the-art and environmental concerns. *Eclog. geol. Helv.* 87, 643–700.
- KRAJEWSKI, K.P., VAN CAPPELLEN, P., TRICHET, J., KUHN, O., LUCAS, J., MARTÍN-ALGARRA, A., PRÉVÔT, L., TEWARI, V.C., GASPAR, L., KNIGHT, R.I. & LAMBOY, M. 1994: Biological processes and apatite formation in sedimentary environments. *Eclog. geol. Helv.* 87, 701–745.
- KROM, M.D., KRESS, N., BRENNER, S. & GORDON, L.I. 1991: Phosphorus limitation of primary productivity in the eastern Mediterranean Sea. *Limnol. Oceanogr.* 36, 424–432.
- MACKENZIE, F.T., VER., L.M., SABINE, C. & LANE, M. 1993: C, N, P, S Global biochemical cycles and modeling of global change. In: *Interactions of C, N, P and S biochemical cycles and global change* (Ed. by WOLLAST, R., MACKENZIE, F.T. & CHOU, L.), NATO ASI Series I4, Springer, Berlin, 1–61.
- SMITH, V.H. 1992: Effects of nitrogen: phosphorus supply ratios on nitrogen fixation in agricultural and pastoral ecosystems. *Biogeochemistry* 18, 19–35.
- VAN CAPPELLEN P. & INGALL, E.D. 1994: Benthic phosphorus regeneration, net production, and oceanic anoxia: a model of the coupled marine biogeochemical cycles of carbon and phosphorus. *Paleoceanography* 9, 677–692.

