

served forming large portions of the specimens collected, or replacing crystals of sulfides, result from low-temperature alteration of preexisting sulfide phases.

The principal silicates are hydrated amorphous silica and iron-silicon nontronite. Minor amounts of muscovite and zeolite were scattered throughout the samples. The sulfates consist mainly of Cu, Fe- and Zn-bearing phases. Small amounts of barite were also detected.

The sulfide deposits described here were probably formed in the axial part of the East Pacific Rise near 21°N during a period of magmatic quiescence. The nature of the polymetallic sulfides, the structural setting of the deposits, and the sulfur isotopic data suggest that they had a magmatic source. The massive sulfide deposits were probably formed by mobilization of sulfide-bearing material and by some reduction of seawater sulfates during fluid circulation in the oceanic crust. Whether the sulfide-bearing material was extracted from basaltic rocks or represents a sulfide melt segregated during the solidification of a silicate melt under the axis of the East Pacific Rise is not yet known.

References and Notes

1. K. Bostrom and M. N. A. Peterson, *Econ. Geol.* **61**, 1258 (1966).
2. Scientific Party, Leg 54, *Geotimes* **22** (No. 11), 19 (1977).
3. R. Hekinian *et al.*, *Oceanol. Acta* **1** (No. 4), 473 (1978).
4. R. B. Scott, P. A. Rona, L. W. Butler, A. J. Nalwalk, M. R. Scott, *Nature (London) Phys. Sci.* **239**, 77 (1972).
5. P. A. Rona, *Mar. Geol.* **21**, M59 (1976).
6. M. Hoffert *et al.*, *Oceanol. Acta* **1** (No. 1), 73 (1978).
7. J. R. Cann, C. K. Winter, R. G. Pritchard, *Mineral. Mag.* **41**, 193 (1977).
8. J. B. Corliss *et al.*, *Science* **203**, 1073 (1979).
9. G. Constantinou and G. J. S. Govett, *Inst. Min. Metall. Trans.* **81**, 1334 (1972).
10. ———, *Econ. Geol.* **68**, 848 (1974).
11. R. H. Sillitoe, *ibid.*, p. 1321.
12. R. W. Hutchinson and D. L. Searle, *Soc. Min. Geol. Jpn.* **3**, 198 (1971).
13. J. D. Smewing, K. O. Simonian, J. G. Gass, *Contrib. Mineral. Petrol.* **51**, 49 (1975).
14. E. H. Bailey and R. G. Coleman, *Geol. Soc. Am. Abstr. Programs* **7** (part 3), 293 (1975).
15. N. A. Duke and R. W. Hutchinson, *Can. J. Earth Sci.* **11**, 59 (1974).
16. R. G. Coleman, *Ophiolites* (Springer-Verlag, Berlin, 1977).
17. J. Francheteau *et al.*, *Nature (London)* **227**, 523 (1979).
18. R. L. Larson, H. W. Menard, S. M. Smith, *Science* **161**, 781 (1968).
19. K. Crane and W. R. Normark, *J. Geophys. Res.* **82**, 5336 (1977).
20. K. C. Macdonald and F. H. Spiess, *Eos* **60**, 376 (1979).
21. F. N. Spiess *et al.* (RISE Project Team), *Science* **207**, 1421 (1980).
22. M. Solomon and J. L. Walshe, *Econ. Geol.* **74**, 797 (1979).
23. CYAMEX Scientific Team, *Eos* **59**, 1198 (1978).
24. ———, *Mar. Geophys. Res.*, in press.
25. P. Picot and Z. Johan, *Atlas des minéraux métalliques* (BRGM, Paris, 1977).
26. G. Kullerud, *Fortschr. Mineral.* **41**, 221 (1964).
27. L. J. Cabri, *Econ. Geol.* **68**, 443 (1973).
28. P. Ramdohr, *The Ore Minerals and Their Intergrowths* (Pergamon, Oxford, 1969).
29. J. L. Bischoff and F. F. Manheim, in *Hot Brines and Recent Heavy Metal Deposits in the Red Sea*, E. T. Degens and D. A. Ross, Eds. (Springer-Verlag, New York, 1969).
30. D. Gottfried and L. P. Greenland, 24th. *Int. Geol. Congr.* (1972), sect. 10, p. 135.
31. J. G. Moore and B. P. Fabbri, *Contrib. Mineral. Petrol.* **33**, 118 (1971).
32. G. K. Czamanske and J. G. Moore, *Geol. Soc. Am. Bull.* **88**, 587 (1977).
33. M. J. Mottl, H. D. Holland, R. F. Corr, *Geochim. Cosmochim. Acta* **43**, 869 (1979).
- 33a. P. Picot and M. Fevrier, in preparation.
34. B. W. Robinson, *Earth Planet. Sci. Lett.* **18**, 443 (1973).
35. H. Sakai, *Geochem. J.* **2**, 29 (1968).
36. Y. Kajiura and H. R. Krause, *Can. J. Earth Sci.* **8**, 1397 (1971).
37. E. T. C. Spooner and W. S. Fyfe, *Contrib. Mineral. Petrol.* **42**, 287 (1973).
38. E. M. Parmentier and E. T. C. Spooner, *Earth Planet. Sci. Lett.* **40**, 33 (1978).
39. J. L. Bischoff and F. W. Dickson, *ibid.* **25**, 385 (1975).
40. J. L. Bischoff and W. E. Seyfried, *Am. J. Sci.* **278**, 838 (1978).
41. S. E. Humphris and G. T. Thompson, *Geochim. Cosmochim. Acta* **44**, 127 (1978).
42. D. E. White, L. J. P. Muffer, A. H. Truesdall, *Econ. Geol.* **66**, 75 (1971).
43. W. S. Phillips, *Inst. Min. Metall. Trans.* **82**, 90 (1973).
44. L. M. Cathles, *Kennecott Copper Corp. Tech. Rep.* 90-443 (1976).
45. C. H. Sondergeld and D. L. Turcotte, *Econ. Geol.* **74**, 109 (1979).
46. R. A. Daly, *Igneous Rocks and the Depth of the Earth* (McGraw-Hill, New York, 1933).
47. B. O. Mysen and R. K. Popp, *Carnegie Inst. Washington Yearb.* **77**, 709 (1978).
48. A. Schneider, *Contrib. Mineral. Petrol.* **25**, 95 (1970).
49. W. R. Normark, T. R. Alpha, G. R. Fess, G. S. Lichtman, C. E. Gutmacher, *U.S. Geol. Surv. Open-File Rep.* 78-350 (1978).
50. N. H. Sleep, *J. Geophys. Res.* **80**, 4037 (1975).
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