face of a fixed supply—assuming the supply is really fixed—is self-contradictory. For as the supply diminishes, the costs of working it rise and growth is slowed or stopped. If growth does not cease, it is because the mineral continues in abundant supply or because substitutes are found.

Limits to growth must exist, and we may for all I know be close to them. I am not sure how much punishment earth, air, and water can take, and we may be running up the cost of cleanliness so fast that unless growth is curbed man's life will soon again become nasty, brutish, and short. These subjects deserve careful examination. It is a great pity that the current excited clamor about nonexistent energy crises and mineral shortages diverts attention and resources from what may be the most serious problem of this century or the next.

If one really believed that mineral resources were becoming increasingly scarce, there would be grounds for austere optimism. Pollution would of itself become increasingly difficult and expensive. Providence would have put a brake on the ability of mankind to poison itself. But there is no sign that we are being let off that easily.

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The Prince of Amateurs

The Mathematical Career of Pierre de Fermat (1601–1665). MICHAEL SEAN MAHONEY. Princeton University Press, Princeton, N.J., 1973. xx, 420 pp., illus. $20.

A quarter of a century ago J. L. Coolidge published *The Mathematics of Great Amateurs* (Oxford, 1949). Explaining the failure to include Fermat, whom E. T. Bell had called the Prince of Amateurs, he wrote (p. vi), "He was so really great that he should count as a professional." Coolidge's decision was, at the time, regretted, for no substantial account of Fermat's contributions was available. Grounds for that regret vanish with the publication of this volume, the first full-length serious study of Fermat's mathematics. It is an altogether exemplary account, for it goes well beyond a catalog of what was done and when, to provide a critical analysis of major aspects in the search for a leitmotif. This could be no casual undertaking, for Fermat was working on the frontiers of his subject at a critical stage in its development. Cartesian geometry bears the name of his chief rival, yet the precepts of the art had first come to the attention of Parisian mathematicians through manuscript copies of Fermat's *Introduction to Loci*. Mahoney's account (pp. 76–142) of this striking case of simultaneity of discovery is excellent. Eschewing a facile comparison of Fermat's analytic geometry with that of Descartes, or with modern views, he has afforded us a penetrating view of its relationship to the earlier Greek geometric analysis. There is also a discussion in detail of technical points, such as Fermat's criticism of Descartes's rules on the simplest curves required to solve geometrical problems.

An outstanding characteristic of this volume is its evenhanded evaluation of Fermat's discoveries. The author does not play the role of a protagonist arguing the case of his hero. This comes out, for example, in the discussion of the method of maxima and minima, for which Laplace had hailed Fermat as the discoverer of the differential calculus. Here Mahoney raises a point which modifies a view widely held by historians of mathematics. Against the customary notion that Fermat's algorithm arose from infinitesimal or limit considerations, he argues very plausibly (p. 148) that it rested instead on "Viète's brilliantly original, but (as befits a professional lawyer) frustratingly casuistic theory of equations." He holds (p. 164) that Fermat's use of the term *adaequalitas*

> . . . has certainly led historians of mathematics astray. For into it they have read the pseudo-equality of the differential calculus. . . . It cannot, however, provide that service. Fermat's method was finitistic, and so too was his use of the term *adequality*.

The word later took on, in the *Treatise on Quadrature* (about 1658) and the *Treatise on Rectification* (1660), a meaning closer to the concepts of the infinitesimal calculus, yet a preoccupation with problems kept him from seeing the fundamental theorem of the calculus (p. 279).

> Fermat found the answers to the problems he had posed. He did not invent the calculus.

In the wealth and beauty of the problems he proposed, Fermat's greatest claim to fame lies in the theory of numbers, where Mahoney's task of analysis was magnified by Fermat's failure to provide completed proofs. The well-known "Last" or "Great Theorem" sums up Fermat's work in that field.

> It is shrouded in mystery because Fermat could not or would not find the time to record his "proof" for posterity, or even for himself. The "proof" probably was no proof, because Fermat could not be bothered by detailed demonstration of theorems his superb mathematical intuition told him were true.

On one minor point (p. 289) the author gives credit to Fermat for a formula for amicable numbers known eight centuries earlier to Thabit ibn Qurra; but this does no harm to the well-substantiated evaluation (p. 280) that

> In number theory especially, one sees the paradox of Fermat's mathematical career: in seeking to renew and continue old, classical traditions, he unconsciously shattered them to lay the foundations of a new modern tradition.

This view, permeating the volume, is later (p. 352) expressed still more sharply:

> In a very real sense, Fermat presided over the death of classical Greek tradition in mathematics.

Earlier one has read (p. 66), concerning Huygens, Newton, and Leibniz, that "they, their colleagues, and their followers could learn little or nothing from [Fermat's] analytic treatises." That this may be too categorical an assertion is suggested by J. E. Hofmann's paper, "Über die ersten infinitesimal, mathematischen Studien von Johann Bernoulli," presented at the Twelfth International Congress of the History of Science at Paris in 1968, in which Fermat's influence on Bernoulli is indicated. Toward the close of the book Mahoney has given a more judicious statement on this problem (p. 353):

> Fermat's failure to publish did not preclude his influence in the development of mathematics in his age and later. It meant, rather, that the influence would be severed from his name. . . . Only number theory would remain Fermat's undisputed province; it would do so, ironically, because Fermat could interest none of his contemporaries in it.

In order to focus attention on the analytic transformation in mathematics wrought by Fermat's problems in the calculus, his contributions to coordinate geometry, and his theorems in the theory of numbers, Mahoney has made these three aspects the chief concern of the 30 sections making up this book. In an epilogue, "Fermat in retrospect," and in two appendices will be found further incidentals, such as Fermat's views in physics and on probability, as well as a "Bibliographical essay and chronological conspectus of Fermat's works." These round out a remarkably satisfying and cogent analysis of the work of one who, though a nonprofessional living in the "century of genius," led all of his contemporaries in the setting and solving of mathematical problems.

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Radiation Chemistry

Neutron Activation Analysis. D. DE SOETE, R. GIJBELS, and J. HOSTE. Wiley-Interscience, New York, 1972. xx, 836 pp., illus. $39.50. Chemical Analysis, vol. 34.

This book tries to give an up-to-date account of the fast-moving field of neutron activation analysis and to provide the scientist new to the field with a rather deep background in the basic nuclear physics of the generation and decay of neutron-activated radionuclides. It performs the second task very well, so well in fact that the first stands a little in shadow. This basic part (actually standing first in the book) spans four chapters after the brief introduction, amounts to about 40 percent of the text, and could be moved to a text on nuclear chemistry without major change. Though one may question the magnitude of the effort, the authors surely construct a firm foundation for the discussion of analytical procedures, to follow.

They then move to the "nuts and bolts" of activation analysis, with a long, valuable chapter on "Preparation of samples and standards": valuable because they gather into one place all the data bearing on the introduction of impurities in reagents and through sampling, handling, and packaging, and the effects of interfering nuclear reactions—in short, because they chart a path through some of the worst pitfalls that surround the activation analyst. My only objection to this chapter is that the discussion of interlaboratory comparison of (especially) multi-element standards is brief and incomplete, a deficiency that is surprising inasmuch as the authors have already cited the International Atomic Energy Agency interlaboratory study in the second chapter. Also, they mention only the two early U.S. Geological Survey standards W-1 and G-1, and not the six current, widely used and more carefully prepared standard rocks. I could not find any reference to Flanagan's two important summaries, though they do refer to the work of Gordon *et al.*

I found the chapter on "post-irradiation radiochemical separations" excellent, with well-organized tables and flow diagrams that will be worth their weight in gold, even at today's speculative prices. The next chapter, "Analysis without chemical separation," unfortunately is somewhat out of date in its emphasis on spectrum stripping and data smoothing and analysis via decay curve decomposition. This chapter may be of use to those still working with NaI-Tl detectors, but that is not where the action is today.

The book concludes with a series of excellent tables and bibliographies—these amount to close to one-third of the whole book and will be of value to anyone in the field. In summary it can be said that the authors have cast their net wide, are perhaps a little unbalanced in emphasis, but have produced a book that will find wide acceptance and use in the field of neutron activation analysis.

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