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Introduction to the Thompson issue

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This issue of the *American Mineralogist* is dedicated to James B. Thompson, Jr., by his colleagues and students on the occasion of his 70th birthday. We celebrate what by any measure must be considered a career of extraordinary contributions to geology over nearly half a century. The realm of Jim Thompson's scientific interests extends well beyond the normal bounds for many members of the Mineralogical Society of America. Yet he has always emphasized to colleagues and students the importance to geology of understanding minerals—both their internal characteristics, and their external "social lives" (his oft-used term for their relations with each other). Because minerals and rocks are so central to his concerns, we believe it is particularly fitting to honor him in the *American Mineralogist.*

Jim Thompson began his geologic career in the field and has yet to let a summer go by without at least a few weeks of field work. To appreciate what he has gleaned from rocks about the origins of the northern Appalachians, one really has to go to the field, to New York, Vermont, New Hampshire, and Maine, armed with one of the many field guides he has written (Thompson, 1954, 1959b, 1972, 1988; Billings et al., 1952; Trask and Thompson, 1967; Theokritoff and Thompson, 1969; Thompson and Robinson, 1976; Thompson and Rosenfeld, 1979; Robinson et al., 1979; Thompson et al., 1986; Chamberlain et al., 1988). Jim was the first to recognize the presence of Alpine-scale nappes in New England, and this has led to the unraveling of complex field relations (Thompson et al., 1968). The Vermont Geologic Map (Doll et al., 1961) was the first of the northern New England state maps to display the complexity of Paleozoic mountain-building processes, based in significant measure on the results of Jim's field work. Soon Jim's latest perspectives on the origin of the northern Appalachians will be provided by *A Guide to Continent Ocean Transect E1: Adirondacks to Georges Bank* (Thompson et al., 1991) and *An Introduction to the Geology and Paleozoic History of the Glens Falls 1° × 2° Quadrangle, New York, Vermont, and New Hampshire* (Thompson, 1991). Jim's astute interpretations of hard field evidence will influence our understanding of New England geology for years to come.

James B. Thompson, Jr.

Jim's first theoretical paper, "The Thermodynamic Basis for the Mineral Facies Concept" (Thompson, 1955), set the agenda for modern studies of metamorphic rocks. This paper profoundly influenced the development of metamorphic petrology and continues to influence the field today. In it, Jim demonstrated the importance of fluids during metamorphism and provided a critical basis for analyzing rock systems open to the passage of fluids. After defining the problems, Jim systematically developed the tools that are needed to help solve them, including graphical projections for the analysis of mineral assemblages in multicomponent systems (Thompson, 1957, 1961; Thompson and Thompson, 1976; Thompson, 1982a), activity diagrams for the analysis of diffusion metasomatism (Thompson, 1959a), thermodynamic and

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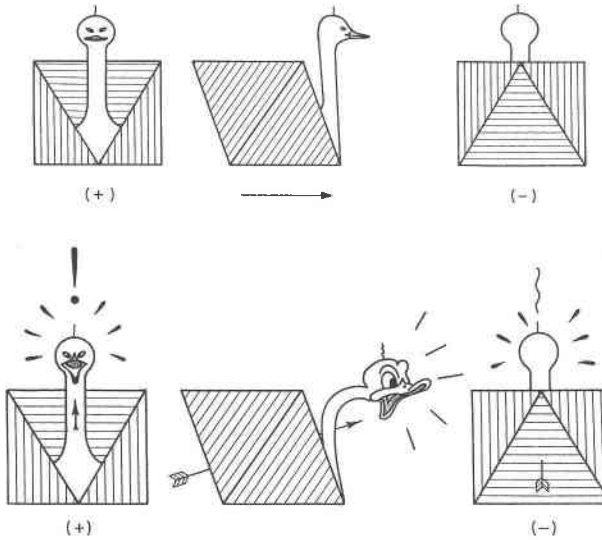

Fig. 1. Octahedra in pyriboles form strips along **c**, and have their symmetry planes parallel to (010). With pyribole (100) horizontal, Thompson chooses pyribole stacking vectors parallel to **c** with their positive direction as that in which the ducks swim (**top row**). These stacking vectors correspond to the horizontal projections of standard mica stacking vectors, which, as Thompson points out, are "distinctly uncomfortable but not necessarily fatal" (**bottom row**). Adapted from Thompson (1981, Figs. 5 and 6).

conceptual tools for the analysis of chemically open systems (Thompson, 1970a), and a reaction space for the quantitative analysis of mineralogic changes during metamorphism (Thompson, 1982b). Some part of this work is woven into the fabric of almost every paper on metamorphic rocks being published today.

The thermodynamics of crystalline solutions, particularly nonideal ones, have been well recognized as difficult to evaluate. In the 1960s as calorimetric data became more accessible and as a wealth of crystal chemical information about cation distributions in complex rock-forming silicates emerged from crystallographic studies, Jim saw that the two could be profitably combined to yield important and complete characterizations of thermodynamic properties. His Presidential Address to the Mineralogical Society of America (Thompson,1969), "Chemical Reactions in Crystals," beautifully built the foundation, while his collaborative experimental work with Dave Waldbaum (Thompson and Waldbaum, 1968a, 1968b, 1969a, 1969b) and later Guy Hovis (Thompson et al., 1974; Thompson and Hovis, 1978, 1979) aptly demonstrated the degree of completeness and understanding for the alkali feldspars.

Jim's analysis of the amphibole crystal structure typifies his scientific approach and his flair for elegant simplicity. Showing us that amphiboles are assembled with alternating (010) slabs of pyroxene and mica (Thompson, 1970b), he clarified instantly many complexities of amphibole crystal chemistry and petrology. Simple geometries led to rules about how classic pyroxene and amphibole I-beam structural components could be stacked, and thus which polymorphs ought to be possible. He stimulated our imaginations with visions of octahedral ducks whose swimming patterns indelibly impressed our memories with the correct I-beam stacking patterns for clino-, ortho-, and the highly metastable protopyriboles (Fig. 1). Using his geometrical parity rules, Jim urged that there ought to be orthopyroxenes and orthoamphiboles around with less symmetry than we usually found. And if amphiboles were alternating pyroxene and mica slabs (. . . PMPM . . .), why not different assemblies of the same slabs? Here was the perfect rationale for reintroducing Johannsen's old field term for dark minerals that were hard to distinguish: *biopyribole* now had a real meaning! Minerals with structures consisting of stackings of varying ratios of the same two (or more) chemically distinct kinds of structural components ought, Jim argued, to be called *polysomes* to emphasize their similarity, and a collection of such structures ought to make up a *polysomatic series* (Thompson, 1978). The quest for the elusive low-symmetry orthobiopyriboles led at about the same time to the blackwall zone of the serpentinite quarry at Chester, Vermont. What Harry Hess had thought was enstatite and Jim had thought was anthophyllite turned out to be new biopyriboles, now known as chesterite (. . . MPMMP . . .) and jimthompsonite (. . . MMPMMP . . .). A simple concept of crystal chemistry that Jim laid out so elegantly is, in fact, a template for nature.

As one might expect, Jim has received honors from three scientific societies. He was awarded the Arthur L. Day Medal of the Geological Society of America in 1964, the Mineralogical Society of America Roebling Medal in 1977, and the V. M. Goldschmidt Award of the Geochemical Society in 1985. In accepting these awards, Jim's words manifest a deeply held concern. As experimental capabilities become ever more sophisticated, and ever bigger and faster computing capabilities put amazing power in the hands and minds of theoreticians, Jim urged us not to forget or ignore the importance of observation. In accepting the Day Medal for "outstanding contributions to geology through chemistry and physics," Jim exhorted the audience to remember that "In the application of chemistry and physics to, say, petrology, we must not, in our enthusiasm, lose sight of the rocks. They are the source of our problems and the final court in which our hypotheses must be tried—at least if they are to be anything more than purely chemical or physical hypotheses." He was very concerned—and still is—about the growing perception that "observational or descriptive geology has little more to contribute." He cut to the heart of the matter: "An outcrop that was drab and uninteresting when studied in a routine manner, through sense of duty, may prove a treasure house of discovery when revisited months or years later and seen again through enlightened eyes. *It is simply that we rarely find more than what we are looking for or expect*" (Thompson, 1964; italics ours). In his acceptance of the Roebling Medal a decade later he again pursued this concern: "I have heard it said, or implied, that the work of mineralogy and petrology, studying the substance of the earth beneath, is largely done, and that bright young scientists would be well-advised to apply their talents to the 'purer' aspects of physics and chemistry. There have been, as some of you may know, a few formal pronouncements to this effect. To me this is a profound and shocking error. God's laboratory, Nature, is not run by the same rules as those in chemistry and physics departments, and would never, I am sure, gain the approval of an inspection team from OSHA. The records, furthermore, are in dreadful shape—but this is what makes it so fascinating" (Thompson, 1979). As a mineralogist, he always urged an interactive relationship with chemistry and physics: "Our sister sciences have provided us with superb tools and methods of thought, but I suspect that we will be able to provide them with problems as long as the pursuit of knowledge is considered worthwhile" (Thompson, 1979).

Throughout his extraordinary career as a scientist, Jim Thompson has had an equally extraordinary career as a teacher. His students, guided and inspired by his impeccable logic and knack of looking at old problems in new and revealing ways, fill a disproportionate share of the ranks of today's leading petrologists. Jim's courses at Harvard have an international reputation, and many petrologists have taken their sabbatical leaves at Harvard to attend his lectures. Many of the papers in this issue have been contributed by Jim Thompson's students. If any doubt exists regarding his success as a teacher, these papers should put the record straight. The range of topics mirrors Jim's interests, and even presses somewhat on the normal bounds of subject matter appropriate for *American Mineralogist*. Given such breadth, it is indeed possible that Jim Thompson himself may be the only person who will understand every aspect of every paper in this issue.

Jim Thompson: field geologist par excellence, preeminent leader of thought for at least three generations of metamorphic petrologists, cajoler of mineralogists and crystallographers, innovative crystal chemist, teacher of teachers. We thank you for your science, your insights, your leadership, your lectures, your friendship, and your continuing advocacy that rocks and minerals do, indeed, have stories worth reading. This issue is for you.

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