Comments and Communications

Fourmarier's Suction Theory of Geosynclines, and the "Vertical Push" Explanation of Geanticlinal Orogeny

THERE seems to be no sign of a revival of interest in T. C. Chamberlin's central-compression theory to account for surface features by a progressive shrinkage of the radius of the earth; but the theory that thermal contraction is competent to account fully for paroxysmal alpine folding, as well as for relatively minor disastrophism, still has strong supporters, despite the radio-geological argument that the earth is not necessarily a cooling body.

Prominent among these supporters is Fourmarier,[1] who, however, rejects the classic concept of horizontal stress and movement, with development of crumpling and dislocation in a zone above a level of no strain (*asténosphere*) in the shrinking earth.

His arguments against movement of kratons as jaws of a vice, and in general against theories of crumpling in front of advancing flakes of rigid continental sial, are based on citation of examples of oval folded tracts, such as the Carpathians, eastern Alps, etc., to show that intensity of folding diminishes outward from an axial zone; such lateral thrusting as is evidenced comes from within rather than from without.

Fourmarier disagrees with the opinion of Suess that vertical movements in the crust are solely downward and are due to gravity acting in the zone above a level of no strain. He regards as of prime importance those movements (downward) due to "suction" along a shrinking radius of the earth (a force he calls "equilibrioturbal"), but recognizes as of great importance others (upward) that are due to the restoring ("equilibriopetal") effect of isostatic readjustment. Suction is appealed to as the force in the formation of geosynclines, where sinking is zonally localized because of absence of homogeneity in the substance of the earth. The possibility that kratons bordering such a sinking geosynclinal belt are drawn closer together is considered remote.

Although he pictures descent of the geosynclinal floor as taking place in response to the formation of a potential vacuum, the author assumes displacement of subcrustal material as a result of this descent—which seems inconsistent. There is also a shift of ground from belief in a rigid substratum, through which tension is transmitted, to an assumption of subcrustal mobility. Indeed, upheaval of adjacent belts, taking place as a result of lateral movement of displaced subcrustal material, is relied on to afford a source of supply of sediment to fill the geosyncline.

An essential part of any such hypothesis involving downward flexure is a halting mechanism. Subsidence becomes increasingly difficult as the light geosynclinal fill is carried down into a zone normally occupied by heavy rocks. Downward suction is resisted and eventually prevented by buoyancy; the potential vacuum shifts to some other—perhaps adjacent—weak zone; isostasy takes charge; and movement is reversed. The compression of the geosynclinal lens, of which there is evidence in the intense folding and dislocations of a tectogene, is attributable to a spewing-out that results from the pistonlike rise of a floor no longer drawn down by suction. The process of deformation must indeed have begun even earlier, during the descent, when at least some dips caused by incompetent folding have been developed, and deeply buried and strongly heated strata may have begun to crumple.

Fourmarier is satisfied with the quantitative efficacy of the theory of thermal contraction. He calculates that a lowering of the temperature of the earth's interior by 100° C would reduce its volume by 3.5×10^9 km^3, which would allow the formation of a basin 63 km deep over the whole area (5.6×10^7 km^2) occupied by mountain welts made during the last 150–180 million years. Such a reduction would obviously be more than sufficient to account for the geosynclines that have been filled. The claim that the reduplication of strata in folds and nappes can be explained by the spewing-out theory is not supported by figures. It may be strongly suspected that excessive estimates have been made by advocates of lateral-compression theories of the organic reduction in width of alpine belts, but Fourmarier would go so far as to claim that their widths have not been reduced at all.

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[1] P. Fourmarier, *Ann. soc. géol. Belg.*, **69**, B87 (1946); *Bull. soc. belge étude géogr.*, **17**, 20 (1947); *Ciel et Terre.* Bruxelles, **67** (1951).

Science Teaching in the Secondary Schools

PROFESSOR SCHRIEVER (SCIENCE, **115**, 96 [1952]) has called attention to the importance of training future science teachers for the elementary and secondary schools. Every potential scientist or engineer goes through these schools and is influenced by them. Also, in these schools most laymen, who become the general public, have their only organized associations with science and scientists, and the contact inevitably influences their attitudes and opinions.

Sadly neglected has been the fact that, despite the efforts of many colleges to revise their science instruction through general education courses, the great majority of people now—and surely for many years to come—complete their study and appraisal of science in the junior and senior high schools. This is immediately apparent when we realize that only about half our children graduate from high school, and that of the graduates only about one in six enters any higher academic institution. Even in college most students restrict their contacts with science to the legal minimum. What happens in the science courses in junior and senior high school should, therefore, be of major interest to all who are concerned with science and with its sympathetic support by the public.

The current laments about the small number of students entering schools of engineering force attention to the teaching and the teachers in the secondary schools, for it is there that the potential engineer decides whether to consider engineering education. Although much to-do is made about a certain unfortunate prognostication of the Department of Labor, we are equally justified in wondering whether the wartime draining of teachers from science classrooms in secondary schools has not brought about uninspired teaching by well-intentioned, but uninformed and ill-prepared, fill-ins.

The competence of teachers in the secondary schools is of vital concern to every collegiate science department. Equal concern must be felt for the junior high schools, for there the students are required to take some science, and they rapidly form attitudes that determine whether they will choose more science from the electives offered in high school. Every student who enters college goes through the lower schools and what happens there is important to those who may have the students later.

There are two points in Schriever's paper that require elaboration: First are some misconceptions about the work load of the secondary school teacher; second, his plea for "suitable" courses in colleges must be clarified.

Schriever mentions that "the teacher of senior high-school science should specialize in the particular science he or she plans to teach;" and later "the prospective high-school teacher [who] may teach both general science and a specialized senior high-school science." Apparently he and many other college professors are unaware of the realities of science teaching in the secondary schools. Half the high schools in the country enroll fewer than 200 students and have total teaching staffs of seven or eight teachers. Furthermore, half the 6,300,000 secondary school students, Grades IX–XII, are in schools having enrollments below 400, with teaching staffs not greater than about 15. As a result, only a very small fraction of the secondary school science teachers teach a single science exclusively. In New York State 53% of the teachers reported three or more preparations per day. Similar but more detailed results are given by Orton from an intensive study during 1948–49 of all but seven of the 2047 certified secondary school teachers in Utah.[1] Although data of comparable detail are lacking for other states, general experience and comments from teachers suggest that such conditions are nationwide.

Orton found that in Utah the number of combinations (in which all the physical sciences—i.e., chemistry, physics, geology, etc.—were counted as one combination [!]) averaged 2.9 per teacher. Furthermore, the number of subjects taught per teacher decreased from 4.4 in schools having fewer than three certified teachers to about 2.6 for schools having 16–50 certified teachers. Not only do all teachers operate in a variety of fields, but often their instruction is not within the areas of either their major or their minor preparation. Table 1, extracted from Orton's extensive tabulations, gives pertinent data.

TABLE 1

Subject	No. having		Total classes in subject	No. classes taught by			
	Major	Minor		Major	Minor	Neither	
Agriculture	109	28	260	207	12	41	16%
Biology	119	158	820	211	166	443	54%
Mathematics	75	159	1287	247	242	798	62%
Political Science	131	195	926	232	231	463	50%
Social Studies	480	490	1627	412	393	822	50%
English	331	450	1909	1022	458	429	22%

It is shocking to find over half the classes in biology, mathematics, and physical science being taught by persons holding neither a major nor a minor in the particular area. But the sciences fare no worse than do the social studies, and even English, in which many teachers prepare, has 22% of the classes taught by relatively unprepared people. Orton's study involved only the "certified" teachers; an additional 200 who were less well prepared and who held only temporary letters of authorization were omitted. What a mockery this makes of the announced criteria of certification! How discouraging this must be to teachers who see someone less well prepared than they teaching their major subject.

Schriever's remarks and numerous comments from other sources have failed to take into account the grim realities of secondary school teaching. There are major problems in designing adequate preparation for future teachers and in ensuring that, once prepared, they are used to maximum advantage in the schools.

Schriever's repeated plea for "suitable" courses in college opens another Pandora's box. Most college instructors have been trained during the past generation to place a high value on the technical application of their particular discipline. Future teachers among the students admire and respect the instructor, adopt his scale of scientific values—as much from what is *not* as from what *is* discussed—and go out to emulate their mentors. It is not surprising, then, that secondary school science instruction has often aped collegiate

[1] Don A. Orton. Appraisal of the Programs of Academic Specialization of Utah's High-School Teachers. Unpublished thesis, Harvard Graduate School of Education (1950).

courses, despite the obvious differences in the audiences. Schriever places before us the question whether science teaching can have any goals other than familiarity with certain technical information. This question is being faced squarely by all those concerned with the part science might play in general education. Both collegiate and secondary school science teachers must continue to explore what might be done and struggle to develop reasonably effective methods to accomplish their goals, for this effort is part of the moral obligation undertaken by everyone who becomes a teacher.

Many strains and some pangs develop during the teacher's reorientation from a high valuation of scientific knowledge per se to some broader picture of how science instruction may reveal the scientist as a person working within the philosophical bounds of his culture, afflicted with prejudices, juggling inadequate and confusing data in an effort to create a bit of order among the multitudinous events in the world around him. Furthermore, our students must recognize the ways by which scientific discoveries and inventions are developed through technology for social good or ill. That the strains are severe is apparent from reactions to some of J. B. Conant's publications, which some contend are "not real science." To many scientists "real science" is embodied in their present courses, which stress technical information. To escape from the problem by such self-congratulation is no solution. Sincere and thoughtful consideration of what may be accomplished through science instruction could result in constructive changes in course objectives and procedures. Despite a growing number of publications and courses illustrating possible changes, ultimately course orientation rests with the individual teacher and his view of his responsibility.

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Book Reviews

Cowdry's Problems of Ageing: Biological and Medical Aspects. 3rd ed. Albert I. Lansing, Ed. Baltimore: Williams & Wilkins, 1952. 1061 pp. $15.00.

The first two editions of this book were published in 1939 and 1942. The present edition, under the able editorship of Professor Lansing, of the Department of Anatomy, Washington University School of Medicine, has undergone such extensive revision that it is practically a new book.

The volume is divided into three sections: "Biological and Cellular Problems of Aging," "Clinical and Organic Problems of Aging," and "Social and Economic Problems of Aging." Of these, the second section, of 742 pages, accounts for the major content of the volume. Unfortunately, of the 47 contributors, only 6 or 7 are actually practicing clinicians. Thus the claim in the subtitle that this volume presents the "medical" aspects is not fully justified. Most of the discussions in this section are essentially considerations of the anatomical and physiological changes observed in senescence and senility. As a basic foundation for geriatric medicine this material is most valuable.

The last section, dealing with the social and economic problems of an aging population, is decidedly sketchy; the four chapters merely scratch the surface of this immensely significant area of gerontology. The omission of any comprehensive discussion of the psychological, including both intellectual and emotional, aspects of aging is most unfortunate. Not only is there no consideration of the changes associated with so-called normal aging, but the section devoted to the psychiatric aspects of aging is but 1½ pages!

What material is presented is invaluable to students and investigators of the complex and urgent problems of gerontology. The volume sins by omission of significant material rather than by commission. A minor but annoying editorial defect is that there is no consistency in the spelling of the oft-recurring word "aging." Even in the text of a single chapter it is sometimes spelled with an "e" and sometimes without.

Typography, illustrations, and binding are excellent, and a great improvement over the bulky second edition. The editor is to be congratulated for the comprehensiveness of the subject matter included. It is not an easy task to bring up to date a book "inherited" from a previous editor and to modify it without destroying the original scheme. If the present volume were to be limited solely to the biology of aging change, the reviewer's praise would be unstinted. As it is, the plan to encompass all the three major aspects of gerontology (the biology of senescence, geriatric medicine, and sociologic gerontology) falls short of the promise in the title. As a reference book, however, this volume should be on the shelf of every serious student of human aging.

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Antennas: Theory and Practice. Sergei A. Schelkunoff and Harald T. Friis. New York: Wiley; London: Chapman & Hall, 1952. 639 pp. $10.00.

Most recent books on antennas have been written primarily either for the practicing engineer with a good deal of experience in radio techniques, or for the advanced research worker with a considerable mathematical background. The present text is written primarily for the student and gives him not only an excellent description of current antenna practice but