Letters to the Editor

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What is a crystallographer?

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Admittedly as a means to stimulate thinking and discussion on the matter of training of crystallographers, Prof. Lonsdale has advanced a number of arguments concerning our profession in a recent issue of this journal (Lonsdale, 1953).

Prof. Lonsdale offers two theses: (1) that crystallography is a science in its own right; and (2) that we are all poorly educated as crystallographers.

I am willing to accept the second of these theses, if by it Prof. Lonsdale intends to imply that we do not hold in our minds all of the material which one might conceivably be called upon to use in a scientific lifetime in this field. But who wants a mind so crammed with facts? It is clear that no one can master all the material in any well developed branch of modern science or technology. Education is most valuable if it develops the ability to know something of the main currents of ideas in a field, and where to look for details. As far as their competence in this direction is concerned, I can think of some very 'well educated crystallographers'; and I would surely place Prof. Lonsdale in a high place among them.

As to the first thesis: this is a point of view held by many members of our profession. In her letter, Prof. Lonsdale includes the following among the points which might support this view: the existence of an active International Union of Crystallography; the fact that crystallographic theory and practice are extremely broad, and it is difficult to teach these to students in the time available; crystallography is really 'the study of the solid state, with all that that implies'; 'the training of a really first class crystallographer must include something of all' of 'the sciences of chemistry, biochemistry, physics, geology, engineering, mathematics, etc.'; there are few places where a thorough training in crystallography can be obtained; unless crystallography is granted a place as a science in and for itself, it will be regarded as pedestrian and simply a highly specialized form of technology. She deplores the distribution within libraries of books on crystallography under "'Chemistry', 'Physics', 'Geology', 'Mathematics' or what-have-you".

My own experience leads me to feel that every competent crystallographer I know is primarily a physicist, a chemist, a mineralogist, etc., or some interesting but well-limited mixture of these. At least he or she is one or another of these for extended periods. I don't know any pure-bred 'crystallographers'; and I would expect that should I ever run across one, he or she would be a technician without much scientific curiosity—a sort of person with a trade but without much self-direction.

'Crystallography' to me encompasses a body of ingenious and often very powerful techniques, applicable in furthering our understanding of certain aspects of physics, chemistry, biology, geology, and various specialized branches of and inter-connections between these. I am convinced that any scientist who contributes effectively and extensively to these fields, whether he be a theoretician or an experimentalist or both, must first be trained as and immersed in one or another of the fields themselves.

It *is* imperative that we teach 'crystallography' as efficiently as possible, and that we provide insight therewith into the power and limitations of crystallographic techniques. But for us to do so under the assumption that we must lay claim to all knowledge which our techniques might assist in uncovering is not merely to take ourselves too seriously, but is to be scientifically unsound. If we wish really to understand the solid state, for example, do we also lay claim to all spectroscopy, all calorimetry, all the field of reactivities in solids, all chemistry below the melting point of all compounds, and so on? Are we to claim, for example, that if X-ray or electron or neutron diffraction provides information, then we have a part of crystallography; and otherwise that we have a part of some other science?

Crystallography was born as a tool in mineralogy; it grew as an aid to chemistry; and today its methods are also advancing our knowledge of physics and biology. Crystallography does not devour these fields as it aids them. Can you name a great 'crystallographer' who was not first of all a scientist in his own field of mineralogy, or chemistry, etc.? I cannot. And I don't believe this is just because of a series of historical accidents, or that we can expect anything else in the future. 'Crystallography' is a broadening influence, not a device for segregating knowledge or scientists.

If practising 'crystallographers' would actually attempt to teach their subject as one which transcends the basic sciences, they would find themselves striving to develop universal intellects, at a point in the development of scientific knowledge where their students could not then be more than dilettantes. If we wish our students to be broadly trained and aware of the basic facts and problems of many sciences, we should not do so merely because our own tool is useful in many fields. Our interests in the fields themselves should motivate us. This advice is as applicable to over-enthusiastic 'crystallographers' as it would be to spectroscopists, microscopists, calorimetrists, cryogenicists, nuclear technologists, and so on and on.

Among the difficulties we must bear in mind is that the more emphasis we place on a particular set of techniques, at early stages of an education, the more basic information of a general nature we must crowd out. This is true in all aspects of modern science. The most precious things we can hope to instill in our best students are interests, curiosities, sound points of view, abilities in selecting significant problems for study, and development of competence *to learn for themselves*—from the published experience of others—specialized techniques or procedures for which they might sometime find need. The worst we can do is cram fine minds full of techniques, many of which will soon be superseded by methods not yet developed. Proposals for crystallographic training often include much material in the latter category. I shall at

least avoid some arguments by not specifying what matters I personally consider to be in this class.

It is true that not all students are capable of becoming much more than technicians. Intensive, extended courses in 'crystallography' *per se* are best designed for students of limited interests, imagination and drive, full of dull patience, who can then be subjected to smatterings of all kinds of basic sciences, and who will be expected to master none. Certain students, far fewer in number, may be capable of acquiring fundamental feelings for and grasp of several basic sciences, no matter what we stuff into them in classrooms and laboratories. Students in this latter class do not pose educational problems; they will learn in spite of what we tell them.

The key to broad and inspired training of both young and experienced 'crystallographers' would seem to lie not in specialized, concentrated, several-year-long courses in crystallographic techniques, but rather in good fundamental training, coupled with association, within one laboratory or institute, with as wide as possible a group of physicists, chemists, biologists, mineralogists, metallurgists, mathematicians and instrumentalists, all working with diffraction methods as one of their major techniques —concerned with the wisest use and development of these techniques, but primarily interested in fundamental scientific knowledge. These workers will not be primarily crystallographers at all; they will be physicists, chemists, etc.; and their work will probably not be pedestrian.

Let us take pride in the fact that books in crystallography grace so many sections of our library shelves. Let us teach our methods to chemists who will remain chemists, physicists who will remain physicists, and so on. Let us attempt, further, to teach physicists to become partly chemists, and vice versa, and so on. Let us seek to infiltrate chemical journals with chemical results obtained by 'crystallographic' methods, and so on. And, above all, let us not seek to have the biggest Union, or the biggest empire, under the title of 'crystallography'.

My admiration would deepen for Prof. Lonsdale, if it were not already so deep, for her ability in starting good arguments as well as accomplishing so much in science. To me she is a great physicist.

Reference

LONSDALE, K. (1953). *Acta Cryst.* **6**, 874.

Notes and News

Announcements and other items of crystallographic interest will be published under this heading at the discretion of the Editorial Board. Copy should be sent direct to the British Co-editor (R. C. Evans, Crystallographic Laboratory, Cavendish Laboratory, Cambridge, England).

International Union of Crystallography

Notice of adhesion in Group I, as from 1 January 1954, has been received from Chile through the National Committee of Crystallography, of which the Secretary is Prof. N. Joel (Laboratorio de Cristalografía y Física Molecular, Universidad de Chile, Santiago).

The number of Adhering Bodies is now 21.

Acta Crystallographica

1. The Editors regret that some copies of Part 3 (March) of the current volume have been wrongly collated: pages may be found to be missing or out of sequence. Subscribers should, therefore, examine their copies carefully and return imperfect copies direct to the publisher (Messrs Ejnar Munksgaard, Nörregade 6, Copenhagen, Denmark) for free replacement.
2. Parts 8 and 9 of the current volume will be published together as a single issue on 10 September 1954.

The British Iron and Steel Research Association

The editors have received a copy of the *Annual Report for 1953* of the British Iron and Steel Research Association. This report, a substantial illustrated volume of 140 pages, contains a general account (79 pages) of the work of the various divisions of the Association followed by a detailed bibliography of published articles and privately issued reports. There is also a useful directory of the many industrial and academic metallurgists connected with the Association and its committees and panels.

Copies of the report may be obtained free of charge from the Information Section of the Association (11 Park Lane, London W. 1, England).

The Size of Particles

The papers presented at a conference on the above subject held at Nottingham University in April 1954 under the auspices of the Institute of Physics are being published as a supplement to the *British Journal of Applied Physics*. Copies can be ordered through any bookseller or direct from The Institute of Physics, 47 Belgrave Square, London S.W.1, England.

Templates for Weissenberg Photographs

Weissenberg lattice row templates, reprinted on transparent Vinylite from Fig. 148 of M. J. Buerger's *X-Ray Crystallography* (1942; New York: Wiley), have now been manufactured and are offered by N. P. Nies, 1495 Coolidge Avenue, Pasadena 7, California, U.S.A. at $1·00 each.

X-ray diffraction by a randomly interstratified clay mineral: correction

An error occurs in Fig. 2(*c*) of the above article by Brown & Greene-Kelly (*Acta Cryst.* (1954), **7**, 101): the ordinates marked 2·8, 3·0 and 3·2 kX. should be marked 2·95, 3·05 and 3·15 kX. respectively.