Verifying Arms Control Agreements

Arms Control Verification. The Technologies That Make It Possible. KOSTA TSIPIS, DAVID W. HAFEMEISTER, and PENNY JANEWAY, Eds. Published in cooperation with the Program in Science and Technology for International Security, Massachusetts Institute of Technology, by Pergamon-Brassey, Washington, D.C., 1986. xvi, 419 pp., illus. $34.95. From a conference, Cambridge, MA, Feb. 1984.

Verification. How Much Is Enough? ALLAN S. KRASS. Lexington Books (Heath), Lexington, MA, 1986. x, 271 pp., illus. Paper, $13.95. Sponsored by the Stockholm International Peace Research Institute.

The Verification Challenge. Problems and Promise of Strategic Nuclear Arms Control Verification. RICHARD A. SCRIBNER, THEODORE J. RALSTON, and WILLIAM D. METZ. Birkhäuser, Boston, 1985. xiv, 249 pp., illus. Paper, $18.75; to AAAS members if ordered from AAAS, $15. A project of the AAAS Committee on Science, Arms Control, and National Security in cooperation with the Stanford University Center for International Security and Arms Control.

For better or worse, verification has been one of the most enduring and tendentious elements of arms control negotiations and agreements. For some, the impressive technical capabilities described in these books are sufficient for much, if not all, of the task of verifying nonintrusively and with reasonable confidence compliance with agreements and treaties. The continuing debate is evidence that nuclear arms control may not be simply a matter of adequate technology for verification, that other issues are involved, and that some technologies may not be sufficient for some very important applications. While the technology of verification has advanced, many political issues have remained unresolved. The three books under review provide extensive but very different commentary on the technological and political facets of verification.

In his introduction to *Arms Control Verification*, Jerome B. Wiesner states, "Neither secret information nor specialized knowledge is needed to understand the issues that really matter in shaping the arms race. . . . To the extent that they can be understood at all, the significant facts of those issues can be understood by anyone who is willing to make a sustained effort to do so. . . . A large body of knowledgeable people around the world could improve the dialogue in which the fate of the earth is discussed." All three books are likely to further this goal. In degree of technicality, they fall along a spectrum, with *Arms Control Verification* and *Verification* very technical and *The Verification Challenge* less so; that is, the latter merely describes the relevant technologies whereas the other two provide details essential for understanding them.

Arms Control Verification contains interesting and at times sweeping presentations of various technologies and subjects, though the contributors' individual predilections make for a less-than-complete coverage of the subject. Particularly good are the chapters entitled "Charge-coupled device image sensors," "Radar imaging for arms control," "ASAT [Antisatellite] treaty verification" and "Some seismological aspects of monitoring a CTBT [Comprehensive Test Ban Treaty]." This last chapter, among the most topical, is by Jack F. Evernden and Charles B. Archambeau, both noted participants in the important debate over the verification of a comprehensive test ban. The chapter, though difficult reading for the uninitiated, should nevertheless be studied by anyone concerned with this debate. One conclusion of the authors that is contentious within the seismic verification community is that "detection of 30 Hertz signals of fully decoupled 0.5- to 1.0-kiloton explosions is possible on a 5- to 8-station basis at 0.9 probability throughout the U.S.S.R." [p. 262].

Other topical issues in the verification debate, besides the comprehensive test ban, include arms control measures for cruise and other small nuclear-armed missiles, mobile intercontinental ballistic missiles, antisatellite weapons, and ballistic missile defenses. *Arms Control Verification*, though superb for the comprehensive test ban, provides only a general review of the severe difficulty of monitoring mobile and small nuclear-armed missiles by traditional means and neglects novel approaches for verifying these otherwise elusive weapon systems. (The editors recount in their preface that the U.S. Central Intelligence Agency forbade publication of two papers apparently on this subject that were prepared by a former member of the agency.) New approaches may be inadequate, but some commentary is warranted. Finally, the chapter on ASAT treaty verification by Richard L. Garwin is an informed and informative review of the topic.

Verification is a more concise presentation of a broad range of technologies, from systems for monitoring and analyzing electromagnetic signals of various wavelengths through seismological analyses to technologies for safeguarding nuclear materials. It provides some technical detail on the verifiability of a comprehensive test ban but is certainly not as thorough on this topic as the chapters in *Arms Control Verification*. The book is similar to *Arms Control Verification* both in describing the difficulties attendant to monitoring mobile and small nuclear-armed missiles, antisatellite weapons, and ballistic missile defenses by traditional methods and in neglecting new approaches for verifying these otherwise elusive weapon systems.

The Verification Challenge provides the general reader with a summary of the technical systems important for verification. It describes how signals intelligence and image and seismic information required for verification are collected and processed and discusses the technical matters involved in verifying a comprehensive test ban. *The Verification Challenge* is similar to the other two books in its handling of the verification of problem weapon systems.

In *Arms Control Verification* the interesting political chapters, entitled "Verification, compliance, and the intelligence process" and "The politics of treaty verification and compliance," describe the arguments over methods, functions, and standards of verification. However, elaborating the politics of verification is neither the thrust of this book nor its strongest feature. In fact, underlying much of *Arms Control Verification* is the view that the only politically necessary function of verification is to provide timely warning of any truly threatening development or deployment and that this is the only standard against which a verification system need be measured.

In contrast, *The Verification Challenge* provides a balanced study of the politics of verification. For the most part, the policy debate concerns the methods, functions, and standards of verification even though the essence of the debate lies in perceptions of the strategic balance and of the threat from the arms race and the Soviet Union. The possibility that something may go undetected or fall outside the bounds of compliance requires determining acceptable levels of risk and behavior by deciding upon the value of an agreement, the military significance of any undetected or noncompliant activity, and the timeliness of discovery and warning. One view of the debate starts from the premise that rough parity exists between the two superpowers so that arms control measures are valuable as a means of stabilizing the strategic situation and halting the arms race; therefore all verification need do is provide warning of new weapons developments or deployments in sufficient time to allow for an effective response and the prevention of a strategic imbalance. An alter-

nate view is that arms control agreements have significance greater than their immediate effect on the arms race so that any questions, infractions, or minor violations are serious issues independent of their immediate strategic significance.

Two particularly compelling examples that could illuminate this discussion are, first, the Soviet SS-25 land-based, mobile intercontinental ballistic missile, which the United States claims is a violation of several provisions of the SALT II Treaty, unratified but heretofore observed (excepting the recent United States action that exceeded a sublimit of the treaty); and second, antisatellite and ballistic missile defense activities, such as the construction of a large phased-array radar in Krasnoyarsk, in relation to the Antiballistic Missile Treaty. One can make valid arguments on the significance of these possible violations that support both points of view.

The author of *Verification* expends considerable effort on reviewing the politics of verification. Addressing an international audience, he attempts to explore the same political issues discussed in *The Verification Challenge* but from an "even-handed" comparison of Soviet and United States positions that often is not convincing. For instance, the discussion of the role domestic politics plays in verification points out the effect bureaucratic politics has on the process. Clearly, the United States suffers, and to some extent benefits, from the competing interests and perspectives various parties bring to the process. However, while justifiably critical of the shortcomings of the United States system, *Verification* diverges from the issues at hand to compare the two countries' systems in the following manner:

> If it were true that arms control monitoring data are almost totally controlled by the military, this would have serious implications for Soviet conduct of the compliance process. High-level policy makers are inevitably dependent on analyses by experts, especially on such complex technical questions as those which arise in arms control verification. It has already been noted in the US context that the temptation for such experts to bias their analyses is great, especially when major bureaucratic or economic interests are involved. However, the historical record of Soviet handling of compliance issues does not show evidence of such a pro-military bias, so it seems reasonable to conclude that the Soviet political leadership has found ways to keep this problem under control. Just what those ways are, however, is not possible to determine [p. 136].

Besides the questionable interpretation that Soviet compliance concerns are unaffected by bureaucratic politics, the differences between United States and Soviet views toward the compliance process are more significant than can be accounted for by bureaucratic politics. Furthermore, the author fails to mention that since the United States depends more on national technical means than does the Soviet Union, which has extensive human intelligence activities and can count on the openness of American society, intelligence estimates here are naturally more controversial. In general, it seems that Krass dilutes the political discussion by convoluting issues in an undiscerning manner.

Thus, the debate over verification is certain to remain as important and contentious as ever. Equally certain is the fact that views on the proper role for verification will, correctly or not, continue to seriously affect the debate over arms control agreements and treaties. In the post-Reykjavik era, as before, "the manner in which the issues of verification and compliance are dealt with by both sides will be an excellent gauge of the seriousness with which they are approaching these new negotiations" (*Verification*, p. 259).

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Anorogenic Granite Complexes

Ring Complex Granites and Anorogenic Magmatism. BERNARD BONIN. Elsevier, New York, 1986. xiv, 188 pp., illus. $45. Translated, with revisions, from the French edition (Orléans, 1982) by John Renouf.

This useful and thought-provoking treatment of granite genesis, emplacement, and evolution during continental anorogenic magmatism reflects the gradually shifting interest from plate margin magmatism to intraplate magmatism. The book, by a single author, has a clear focus that is often absent in collective volumes. Bonin presents his own views eloquently while also offering critical appraisals of other points of view. The translation is of a very high standard.

Starting with the example of Corsica, a country with 20 granite ring complexes and over 1000 meters of vertical exposure, Bonin discusses the structural setting and intrusion mechanisms in an initial chapter that includes a brief historical review, a summary of experimental approaches, and an outline of magma generation in the asthenosphere with subsequent movement into the crust. After dealing with the textures and mineralogy of ring complex granites, Bonin presents chemical data (expressed in various graphical plots of major and minor elements) and strontium isotope data. These data are then set in the context of a discussion of magmatic evolution and postmagmatic processes based on examples of anorogenic granite complexes in Corsica, the Greenland Gardar province, Skye, and the Jos Plateau of Nigeria. A penultimate chapter entitled "The origin and evolution of anorogenic alkaline magmatism" pulls the discussion together. The question of origin is approached by an examination of the petrological and geochemical constraints combined with an essential constancy of composition throughout geological time, characterized by a K_2O content of up to 7%, a very high rare earth content, and an initial $^{87}Sr/^{86}Sr$ of 0.702 to 0.709. The contrasting views of fractional crystallization of basic magma and partial fusion are examined. The rise of the magma into the crust is considered along with the role of crustal contamination, magmatic evolution, and the role of water. Finally, the postmagmatic processes of hydrothermal alteration and mineralization are outlined.

Bonin summarizes his views in a succinct final chapter. He concludes that anorogenic magmas originate in the mantle but that the crust superimposes a final character on them. Bonin does not pretend to offer a definitive explanation of ring complex granites, but in a modest 172 pages he presents an eminently readable summary of their nature, composition, structural setting, and probable origins.

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Particle Detectors

Introduction to Experimental Particle Physics. RICHARD C. FERNOW. Cambridge University Press, New York, 1986. x, 421 pp., illus. $44.50.

In most fields there are a few unwritten books that everyone agrees are needed but that no one has time to write. For particle physics, one such book has been a comprehensive survey of the experimental techniques used to unlock the secrets of the subatomic world. Richard Fernow's book fills this need.

Fernow covers most aspects of particle experiments, from the fundamental interactions of elementary particles with matter to how these interactions are exploited to build particle detectors and finally how the detector components are integrated into the large detector systems that form the basis of modern particle experiments. Most of the book is devoted to particle detectors. There are sec-