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RESULTS OF BLIND TESTS TO RESOLVE CONTROVERSIES: IRIDIUM AT GUBBIO; EXTINCTIONS AT EL KEF. Compiled by R. N. Ginsburg[1] from analyses of F. Asaro[2], M. Attrep Jr.[3], J. I. Canudo[4], J. H. Crocket[5], U. Krähenbühl[6], B. Masters[7], H. T. Millard Jr.[8], R. K. Olsson[9], C. J. Orth[3], X. Orue-etxebarria[10], L. R. Quintana[3], and R. Rocchia[11], [1]University of Miami, Miami FL 33149, USA, [2]Lawrence Berkeley Laboratory, Berkeley CA 94720, USA, [3]Los Alamos National Laboratory, Los Alamos NM 87545, USA, [4]Universidad de Zaragoza, Zaragoza 50009, Spain, [5]McMaster University, Hamilton, Ontario L8S 4K1, Canada, [6]Universität Bern, Bern CH-3000, Switzerland, [7]Sapolpa OK 74066, USA, [8]U.S. Geological Survey, Denver CO 80225, USA, [9]Rutgers University, New Brunswick NJ 08903, USA, [10]Universidad del Pais Vasco, Bilbao E-48060, Spain, [11]CNRS Laboratoire, Gif-sur-Yvette 91198, France.

Two of the many controversies about KT events are based on differing results of analyses of samples from the same outcrops between two or more workers. One concerns the distribution of Ir across the boundary in the much-studied sections at Gubbio, Italy; the other involves the patterns of disappearance of planktonic Formanifera in the boundary section at El Kef, Tunisia. At the 1988 Snowbird Conference it was proposed that proponents of the differing interpretations join in collecting comprehensive samples for a blind test to resolve the differences.

For the sections near Gubbio, 16 samples were selected for analysis, including those that could settle the controversy and placebos from other localities. The samples were ground in a ball mill and splits were distributed blind for analysis of Ir to six analysts: Asaro, Crocket, Krähenbühl, Millard, Orth, and Rocchia. The results to be presented have settled the controversy.

For the El Kef sections, closely spaced samples were collected across the boundary under the supervision of the two proponents of differing interpretations. The samples were split and distributed blind to four micropaleontologists: Masters, Canudo, Olson, and Orue-etxebarria. The results to be presented indicate the status of the controversy.

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SCIENCE OBSERVED: THE MASS-EXTINCTION DEBATES. W. Glen, Stanford University Press, Stanford CA 94305-2235, USA, and c/o Mail Stop 930, U.S. Geological Survey, 345 Middlefield Road, Menlo Park CA 94025, USA.

The upheaval triggered in 1980 by the Alvarez-Berkeley group impact hypothesis transformed the literature of mass extinctions from an unfocused, sporadic collection of papers that virtually ignored extraterrestrial causes and treated endogenous ones only sparingly better to an integrated, diverse body of literature. Research programs organized seemingly overnight spawned collaborative teams whose members (often from distant, isolated disciplines) redirected their careers in order to address the captivating, high-stakes issues.

The initial, generally skeptical cool reception of the impact hypothesis might have been predicted for any of a number of reasons: Such an instantaneous catastrophe contravened Earth science's reigning philosophy of uniformitarianism; it was formulated from a form of evidence (siderophile element anomalies) alien to the community charged with its appraisal; it advanced a causal mechanism that was improbable in terms of canonical knowledge; and it was proffered mainly by specialists alien to Earth and biological science, especially paleobiology.

Early on it became clear that irrespective of which causal hypothesis was chosen, the chosen one would be the strongest predictor of how the chooser would select and apply standards in assessing evidence bearing on all such hypotheses. Less strong correlation also appeared between disciplinary specialty and choice of hypothesis, and between disciplinary specialty and the assessment of evidence. Such correlations varied with the level of specialization; the most robust correlations appeared in the most restricted subspecialties—the weakest in the broadest areas of science practice. The gestalt (mindset) seemingly engendered by the embrace of an extinction hypothesis overrode, or was stronger than, the intellectual predispositions attributable to disciplinary specialty.

The great majority of paleontologists rejected outright or eschewed impact theory at its advent, and most who later came to believe in an impact event(s) at the KT boundary still deny impact(s) as the main extinction cause. Many paleontologists regarded the duration, severity, and other aspects of the KT mass extinction in terms of the fate of their own fossil taxa at the extinction boundary; specialists in severely affected fossil groups were most often among those who spoke of a connection between impact and the mass extinction. Certain subspecialty communities within paleontology differed markedly in their opinions on the cause of mass extinction: For example, vertebrate paleontologists were almost unanimously opposed to impact-as-extinction-cause; in contrast, micropaleontologists—especially those treating planktonic calcareous forms—were most often oppositely inclined.

Most cosmo- and geochemists, planetary geologists, impacting specialists, and students of Earth-crossing comets and asteroids were immediately sympathetic to impact theory in its entirety. Study of impacting and closely related topics appeared to foster sympathy for the impact hypothesis; however, most volcanologists (volcanic specialists) did not accept the volcanist hypothesis—which was not conceived by volcanologists—but no unusual proportion of volcanologists favored the alternative impact hypothesis.

Published authors and published supporters of alternatives to the impact hypothesis of mass extinction, examined in all cases save one, were opposed to the impact hypothesis at its advent. Irrespective of their discipline, or however poorly informed, scientists rarely failed to embrace one of the mass extinction hypotheses.

The use of obsolete data and/or the omission of contrary evidence almost always punctuated published and oral arguments, and opposing views were never treated at equal length. The gestalts or cognitive frames of members of the opposing theoretical camps seemingly precluded mutually congruent viewpoints on any of the important debated issues or the assessment of evidence. The widely held view that such adversaries suffer an "incommensurability of viewpoint" seemed understated.

Impactors (proponents of impact as extinction cause) and volcanists (proponents of volcanism as extinction cause) commonly used different standards of appraisal and weighted the same evidence differently. Application of standards and weighting of evidence varied widely even among those in the same theoretical camp. The impactors argued mainly from canonical standards and claimed that their hypothesis—backed by empirical evidence—facilitated clear predictions with implicit directions for testing. The prediction of impact-generated, global, ballistic transport of impact products raised expectations for many that impact evidence in addition to Ir would be found at KT boundary sites—this provided important impetus for the rapid formation of diversely comprised research teams. Almost always, the members of the same collaborative team subscribed to the same extinction hypothesis.

Impact's opponents focused on the great range of variation in the character of the boundary interval around the world, emphasizing that the geographic variations indicated a cause that was neither global nor instantaneous. It was a prime mission of impact's opponents to demonstrate a lack of the ubiquitous, globally uniform effects claimed for an impact. Unlike the orthodox evidence that was advanced for the radical impact hypothesis, impact's active opponents—mainly the volcanists—sought to undermine a wide range of suppositions and vagaries that lay long hidden in established principles and methods; the volcanists searched for the weaknesses in the orthodox standards and thus prompted much research at unprecedented levels of refinement. The call for higher resolution and greater detail required the development of new, or the acquisition of theretofore unused, methods, techniques, and instruments in a number of disciplines; such needs were often fulfilled through the formation of appropriately composed collaborative teams.

In the mid 1980s the postulate of stepped or multiple extinctions near the KT boundary evolved through a series of recognizable stages. The evidence for extinction steps was initially viewed as an anomaly in terms of the single-impact hypothesis and, as such, was more or less dismissed early on by the impactors. But it then became an increasingly serious problem as supporting data accrued and stepped extinctions approached the status of a normative assumption. Ultimately, with further affirmative evidence, the stepped-extinction idea, and all it came to imply in terms of impugning single-impact theory, evolved into a standard of appraisal that drove the reassessment of the nature of extinctions at the KT boundary. At that point the newly born standard of multiple extinction steps—which had begun life as an anomaly in terms of the single-impact hypothesis—evolved into the primary forcing function that forced the reformulation of the single-impact hypothesis into a hypothesis of multiple impacts spanning enough time to accommodate the extinction steps.

Leadership of the various factions engaged in the debates was, in all cases, clearly in the hands of only one or very few senior leaders who exercised magisterial authority. Such doyens were most frequently sought for their opinions on debated issues by both their own communities and the media; that was reflected in both the publications of science and the public. The rapid pace of the mass extinction debates, with which only few could keep abreast, seemed to add to general reliance on the magister. Such two-step communication, from the world to the magister and then from the magister to the world, has been documented in other studies of conflicted ideas.

Closure has not been reached on any of the many issues reticulated in these debates, but most Earth scientists are now convinced of at least one impact at the KT boundary and many are inclined to think in terms of multiple impacts, either instantaneous or spread over 1–3 m.y.; however, far from all who subscribe to impact(s)—especially among paleontologists—view impact(s) as the chief cause of the mass extinction(s).

Research programs organized in the past decade to address the many issues that have arisen in the course of this upheaval continue to generate new publications at a surprising rate (more than 2500 have already appeared). Modeling of impacts and mantle plumes and their effects on a number of internal, crustal, and biospheric processes grow increasingly sophisticated with different research approaches showing promising convergence in their conclusions. The search for impact sites, which includes the reexamination of many long-enigmatic structures, and the remapping and dating of great flood basalt bodies are being actively pursued. Mass extinction horizons throughout the Phanerozoic are being scrutinized with methods, techniques, and instruments that did not exist just a decade ago, and the broad character of the debates has forced unprecedented interpenetrations of long isolated subdisciplines. The debates continue, sustaining the opportunity to study the workings of science during a time of conflict over several related theories that span multiple disciplines. The intensity, fast pace, and disciplinary diversity of this upheaval has opened windows on the workings of science where only peepholes had been expected. These conclusions and others, and a historical overview of the debates are detailed by me and a dozen other scientists and social studies of science scholars in [1].

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BIOSTRATIGRAPHIC EVIDENCE OF THE KT BOUNDARY IN THE EASTERN GULF COASTAL PLAIN, NORTH OF THE CHICXULUB CRATER.

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The KT boundary in Alabama is currently being restudied in light of the proximity of this area to the Chicxulub impact crater in the Yucatan Peninsula of Mexico [1,2]. Previous studies have suggested that there is an apparent discordance between the position of the KT boundary and the stratigraphy based on the Ir anomaly pattern [3], paleomagnetic reversals [4], and the major biotic extinction event [5]. The purpose of this paper is to present the biostratigraphic evidence from dinoflagellate cysts [6], calcareous nannofossils [7], and planktonic foraminifera [8] to show that the mass extinction datum is situated precisely at the KT boundary in Alabama and that the low values of Ir peaks in the sediments directly above the bound-