NEWS IN BRIEF

LARGE IMPACT HYPOTHESIS FOR THE MOON

The idea that the Moon represents material blown off the young Earth by an impact of a huge planetary object is now back in favour (Science, November 30, 1984, p. 1060-1061). In mathematical models prepared by A.G.W. Cameron (Harvard-Smithsonian Center for Astrophysics), the object falls to Earth at speeds >40,000 km per hour, hits it at an oblique angle, vaporizes its own rocky outer mantle and an equivalent amount of the Earth's, and blows this material into orbit. The latter process would be aided by expanded gases produced by the impact, like the "second burn" of a rocket in launching a satellite.

The new interest in the large impact concept is due in part to failure of classical theories of rotational splitting-off of the Moon from a rapidly spinning molten proto-Earth, the gravitational capture of the Moon as it wandered by, and simultaneous condensation of the Earth and the Moon from the same cloud of gas and rock. The impact theory helps to explain the scarcity of iron in the Moon, which would have formed from the iron-poor mantles of the Earth and the impact object.

MID HOLOCENE HUMIDITY IN THE EASTERN SAHARA

Between about 4,500 and 12,500 yBP, the climate of the Eastern Sahara was significantly humid, according to a growing body of evidence from geomorphology, sedimentology, archaeology and paleopedology. This is now strengthened by analyses of sediments and their pollen from annually-layered lake deposits in the Oyo Basin of northwestern Sudan, in the hyperarid core of the Sahara. Samples collected by C.V. Haynes (Southern Methodist University, Texas) from a 5m-deep pit in the center of a small basin, have now been analyzed by J.C. Ritchie and C.H. Eyles (University of Toronto, Ontario).

The sediments at the base consist of annual carbonate laminae deposited in a chemically stratified lake, succeeded upwards by carbonate muds marked by soft-sediment structures. These are covered by a coarsening-upward sequence of highly deformed dolomitic muds and finally by bleached aeolian sands (Nature, in press). The pollen content of the sediment indicates an earlier environment with trees characteristic of a modern deciduous savanna like the one that

exists some 500 kilometres to the south, later succeeded by an increase in elements typical of modern Sahelian savannas and thorn scrub vegetation.

These data, combined with C14 analyses, indicate that between 9,000 and 6,100 yBP the Oyo region supported a relatively deep, stratified lake with stagnant bottom waters and annual inputs of fresh water, in a humid tropical climate with an annual monsoonal rainfall of 400 mm or more. Around 6000 yBP, there was a reduction in precipitation (to about 300 mm per year) and/or an increase in evaporation causing the lake to become more shallow. This process continued to 4,500 yBP (precipitation <100 mm per year) when the lake was buried by wind-blown sand, and the desert scrub/grassland vegetation disappeared, except at oases and wadis. The inferred Oyo climate is in agreement with recent work on Lake Chad sediments in the central Sahel, with general Holocene lake-level trends for northeastern Africa, and with changes in the position of the African monsoon predicted using Milankovitch orbital forcing.

U.S. OIL RUNNING OUT?

A 17% decline in American oil production by the year 2000 has been predicted by a U.S. Library of Congress resource analyst, according to Science (26 October 1984, p. 426). If discoveries do not pick up soon, Joseph Riva says that production may even drop by 29%, and those who claim that production can be maintained if industry is given a fair profit and a free hand must be wrong. Like many others, he considers the U.S.G.S. estimates of undiscovered oil in the Rocky Mountains, off the Atlantic coast and maybe even in Alaska to be overly optimistic, especially in light of recent disappointments in exploration drilling. The 29% production decline still assumes a discovery rate in Alaska equal to the one that included discovery of the super-giant Prudhoe Bay field. A distinct downward trend in U.S. oil production should show up in a few years, as field depletion overwhelms the unprecedented drilling of production wells of the past five years.

GEOLOGICAL RHYTHMS DUE TO COMETARY IMPACTS?

The idea of fundamental cycles in earth history related to extraterrestrial impacts is rapidly gaining in popularity. Further support comes now from recent statistical analyses on a long time series of geological and

geophysical data carried out by M.R. Rampino and R.B. Stothers (Goddard Space Center, USA). Their data include records of tectonism, climate change, sea level variation, mass extinction, sea floor spreading and magnetic reversals, some going back to 2 Ga. As reported in Science (December 21, 1984, p. 1427-31), two dominant periodicities at 33 ± 3 Ma and 260 ± 25 Ma exist, with statistical significance at 99.9% confidence level.

Rampino and Stothers regard these cycles as causally related to similar ones involving impact cratering. The 33 Ma cycle is thought to be related to the half-period of the vertical oscillation of the solar system about the galactic plane, and the resulting encounters with its preferential concentration of massive stellar clouds. This leads to episodic gravitational perturbation of the sun's family of comets, some of which strike the earth. The 260 Ma cycle of impact cratering may be related to the revolution of the sun around the galactic centre. Rampino and Stothers have not detected any decay in time of these cycles.

...TO CHANGES IN SEA LEVEL AND CLIMATE?

Opposition to the concept of periodic extinctions caused by extra-terrestrial impacts is still, however, widespread. A. Hallam (University of Birmingham, U.K.) questions both the reliability of the time scale used and the definition of a mass extinction (New Scientist, November 8, 1984, p.30-33). Some of the stage boundary subdivisions used by Raup and Sepkoski in their original analysis are subject to errors of 5 Ma or more, and there is considerable disagreement between recently proposed time scales. Some of the possible mass extinction events involve rather small numbers of families, and the assumption that extinction took place at the end of each stage marking the last appearance may be incorrect. Hallam argues instead that cyclic changes in sea level and climate, often linked one to the other, were heavily involved in mass extinctions.

...OR TO VOLCANISM?

In a similar vein, a link between evolutionary crises and the widespread subaerial and submarine volcanism associated with major rifting events is supported by J. Campsie (Ocean Study Group, Copenhagen, Denmark), G.L. Johnson (Office of Naval Research, Arlington, Virginia), J.E. Jones (University of Copenhagen), and J.E. Rich

(Office of Defense Cooperation, Copenhagen). They point out that the five major extinctions for which there is general agreement (including those at the ends of the Permian, Triassic and Cretaceous) and several minor ones can each be correlated with a major volcanic event (EOS, November 6, 1984, p796-800).

The effects of submarine volcanism on living matter may have been chemical (e.g. toxicity) or biological (e.g. the intense activity around submarine vents - possibly the sites for "mutagenic inputs"). Volcanic injections of CO₂ (perhaps accompanied by Ir) into the atmosphere would have had substantial effects on biota, as would catastrophic events like tsunami and floods due to volcanic eruptions. While admitting that no single factor can adequately account for the correlation between rifting and biotic crises, the authors support many others who link volcanism and major evolutionary events.

MASSIVE SULPHIDES IN THE RED SEA

Massive sulphides were discovered recently in the northern Red Sea outside the axial troughs which have long been known for their metalliferous muds. The Italian research vessel Bannock dredged pyritiferous slabs up to 10cm in size from the slopes of a small mount at 23°45'N and 36°17'E and water depths from 769 to 1,140 m. According to E. Bonatti (Lamont-Dougherty Geological Observatory New York), P. Colantoni and M. Taviani (CNR, Bologna), and P.L. Rossi (University of Bologna), these sulphides may be related to a NE-SW fracture zone crossing the northern Red Sea in a direction parallel to the Dead Sea-Gulf of Aqaba transform fault.

CANADA'S LITHOPROBE DETECTS SUBDUCTING SLAB

Lithoprobe is Canada's equivalent to the COCORP, BIRPS and EGT programs to investigate deep crustal structure. Phase 1, completed in mid-1984 as a pilot project for an extended series of seismic profiles, focussed on southern Vancouver Island and the Kapuskasing structural zone of the Canadian Shield.

The former region is a zone of transported terranes subjected to present-day tectonic activity. Two hundred km of seismic reflection profiling were run, using the Vibroseis source and 120 recording channels, with two-way travel times extended to 15

seconds. The high-quality profiles allow clear recognition of a down-going slab, probably with subducted sedimentary rock above, and the outlining of geological structures such as faults in the upper-most part of the crust.

The Kapuskasing test run involved mainly seismic refraction and showed several dipping reflectors, which could represent Precambrian thrusts bringing up the lower continental crust. Seismic profiles were also run in 1984 across the Atlantic continental shelf (Lithoprobe East) under the terms of the new Frontier Energy Geoscience Program of Canada's Department of Energy, Mines and Resources. This is aimed at investigating the geology, deep structure and evolution of sedimentary basins marginal to the Canadian coastline.

SM, ND AND SEDIMENTARY RECYCLING

Several important implications for the age, history and composition of the sedimentary mass of the continental crust have been obtained from a recent study of samarium and neodymium isotopes in particulates from major and minor rivers of the Earth, continental sediments, and airborne dust collected over the Atlantic, Pacific and Indian Oceans. S.L. Goldstein, and R.K. O'Nions (Cambridge University, U.K.), and P.J. Hamilton (Scottish Universities Reactor Center, Glasgow, U.K.) have shown that the Sm/Nd ratios and isotopic compositions in contemporary continental erosion products vary within very small ranges. The whole sedimentary mass appears to have an average crustal residence age of 1.9 Ga (Earth and Planetary Science Letters, v. 70, p. 221-236, 1984).

The Nd isotope compositions in the particulate input from the continents to the oceans is the same as Atlantic sediment and sea water but lower than those of the Pacific, thus demonstrating the importance of Pacific volcanism to Nd geochemistry there. The average Sm/Nd ratio is about 0.19 in the upper continental crust and has remained so since the Early Archaean. This precludes the likelihood of major felsic-mafic trends in the overall composition of the continental crust through Earth's history. The uniformity of the Sm/Nd isotopic systems in river and wind-borne particulates appears to reflect efficient recycling of old sediment by sedimentary processes on a short time-scale compared with the amount of time the material has resided in the crust.

RAPID CLIMATIC RESPONSE FROM NUCLEAR "EXCHANGES"

The nuclear winter theory has now received strong support from a report issued by the US National Research Council. While declining to make quantitative estimates because of the large uncertainties involved, the report concludes that a "clear possibility" exists that a major nuclear exchange could produce enough smoke and dust to cause severe temperature drops over much of the north temperate zone, lasting weeks to months.

Using a base-line case involving detonation in a general nuclear "exchange" of 0.5% of the current world arsenal of nuclear weapons (25,000 weapons with a total of 6,500 megatonnes), the assumption is that about 1,500 megatonnes would explode at groundlevel, with the balance of 5,000 megatonnes detonated above surface to destroy military, economic and political targets, including about 1,500 megatonnes over 1,000 of the world's largest cities, all between 30°N and 70°N in NATO and Warsaw Pact countries.

This nuclear exchange would lift about 15 megatonnes of dust particles into the upper atmosphere where they could remain aloft for over a year. Here they could reflect the sun's radiation, causing surface cooling of land areas as in the case of dust from volcanoes and Saharan storms. Smoke from massive fires in cities and forests could result in much greater surface cooling by blocking solar radiation. Light levels could also be reduced by 99% or more over large areas of the Northern Hemisphere, and these effects could spread in a few weeks into the Southern Hemisphere, though they would be less extensive there than in the north. Various mathematical simulations used in the report yielded temperature reductions of 10°-25°C, returning to normal in about six to twenty weeks.

The report does not, however, endorse any numerical estimates, because current models are useful only for estimating the "potential seriousness of atmospheric degradation" and are not reliable enough for scientific predictions. ("The Effects on the Atmosphere of a Major Nuclear Exchange" National Academy Press, 1984).

... AND VOLCANIC ERUPTIONS

Support for the nuclear winter concept has also come from a recent study of how the atmosphere responds to major volcanic eruptions. P.M. Kelly and C.B. Sear of the University of East

Anglia's Climatic Research Unit (U.K.) are studying monthly temperature data following eruptions in the Northern Hemisphere of volcanoes such as Pelée in Martinique and Bezymianni in the Soviet Union (Nature, October 25, 1984, p. 740-43). Although most recent studies have suggested that the global effects of volcanic dust take a year or more to become established, Kelly and Sear have shown that there is an immediate and rapid decrease in surface temperatures across the hemisphere following major eruptions, and that these reach a minimum in the second month after the eruption, recovering only slowly over the next two years. If the eruption occurs in winter the maximum depression of temperatures is about 1.4°C, whereas in summer the effect is about one third of this.

NEW HOMO ERECTUS FIND

An almost complete skeleton of a 12 year male *Homo erectus* who died 1.6 Ma ago was found last August on the western shore of Lake Turkana by Kamoya Kimeu, head of the hominid hunting team of the National Museum of Kenya. This species was formally known mainly from cranial material found in Africa and Asia (at times called Peking Man and Java Man). According to Alan Walker of The Johns Hopkins University (Baltimore, U.S.A.), the bones looked remarkably like those of modern humans, but there are also interesting anatomical differences, for example in the structure of the upper thigh bone, the pelvis, and thoracic vertebra. The Turkana boy stood at around 1.6 m, confirming what had been suspected from other fragmentary finds - that *Homo erectus* was bigger than most populations of modern *Homo sapiens*.

NEW IDEAS ON TROPICAL FOREST EVOLUTION

Concepts about the climate of the tropics and neo-tropics during the Pleistocene have changed dramatically in recent years. These areas were traditionally regarded as experiencing winter conditions, while the rest of the planet froze in glacial advances. In contrast, recent evidence from oxygen isotopes and plankton in deep sea cores suggests that land masses near the equator were mainly cool and dry. This now receives strong support from pollen profiles in lake sediment cores from northern Guatemala, analysed by Barbara Leyden of the University of Florida (Proceedings of the National Academy of Science U.S.A., v. 81, p. 4856, 1984). Her

analyses indicate that around 11,000 yBP there was a cool and arid scrub savanna where now a lush tropical forest stands. The transition to the rich modern diversity was via a brief period of pine, oak and temperate hardwoods, indicating cooler and wetter conditions than today. Clearly then, these tropical forests were not "ageless" refuges that resisted the cool glacial times of the Pleistocene. Rather, they have acquired their diversity through environmental instability, as in other cases of biological development.

DOES ENVIRONMENTAL CHANGE DRIVE EVOLUTION?

The wide belief among biologists that changes in environment drive evolution is now being tested by terrestrial and marine (DSDP) data which appear to show correlations between climatic and evolutionary events in many different formal groups. These data were reviewed for the Neogene at a recent workshop at Colombia University in New York (see R. Lewin, in Science, October 12, 1984, p. 154-157). The most striking correlations were at about 2.4, 5 and 15 Ma ago.

The broad picture, as worked out from deep sea cores, is one in which the relatively warm climate of the Palaeogene was brought to an end mid-period by the northward drift of Australia. This caused the isolation of Antarctica by the circum-Antarctic current, resulting in a global cooling some 40 Ma ago and an increase in the temperature gradient between poles and equator. The first signs of ice in Antarctica appeared about 30 Ma ago, and 14 Ma later the eastern ice sheet was in place, followed 5.5 Ma ago by the western ice sheet (and the transient drying of the Mediterranean). The north polar ice was in place 1.4 Ma ago and the ice ages began here about 0.9 Ma ago.

The land record is more patchy, but in the Siwalik Hills of Pakistan, a diverse group of apes disappeared rather suddenly about 7 Ma ago at the onset of a cooler, dryer climate. From Africa, data on bovids indicate bursts of speciation around 0.9, 2.4 and possibly 5 Ma ago.

The search is now on for other data sets that could reveal just how synchronous pulses of extinction and speciation were. One specific proposal now being followed up is to obtain a long marine drill core close to the East African coastline, in order to link the deep sea record with that

emerging from fossiliferous ash-laden sediments of the Rifts.

SPHERULES AT K/T BOUNDARY SUPPORT IMPACT CONCEPT

Sediments from the Cretaceous-Tertiary boundary at two locations in Italy have been found to contain spherulites with small crystals of magnetite in a highly altered groundmass. According to J. Smit and F.T. Kyte (Nature, August 2, 1984, p. 403-405), their commonly spherical shape indicates rapid growth from a high-temperature liquid. These spherulites also have higher concentrations of iridium and probably other siderophile elements than the bulk sediments. Similar samples found in DSDP cores taken from the Shatsky Rise of the northern Pacific are somewhat reminiscent of chondritic cosmic spherules, but concentrated about 5,000 times more than cosmic spherules in abyssal clays. These findings support the theory of a major accretionary event at the end of the Cretaceous.

BUT THE EOCENE/OLIGOCENE TRANSITION WAS A GRADUAL ONE

On the other hand, studies by B.H. Corliss and co-workers (Science, November 16, 1984, p. 806-810) on the Eocene/Oligocene boundary in the deep sea show gradual biotic changes in planktonic and benthic foraminifera, calcareous nanno-plankton, and planktonic diatoms. They were unable to detect any mass extinction event at this level, despite earlier reports of an iridium anomaly in the latest Eocene associated with extinctions in the marine and terrestrial record. They suggest that these late Paleogene changes reflect variations in paleoclimate and paleo-oceanographic conditions rather than an extra-terrestrial impact.

K-T boundary - at the base of the dark lignitic layer just below knee level. Scoltard Fm. Buffalo Jump Park, Alberta. (D.A. Russell).

GÉOCHRONIQUE

The French-language Earth Sciences magazine

published by
The French Geological Society
together with
The Bureau de Recherches Géologiques et Minières

GEOCHRONIQUE appears **quarterly**, in French, with sections on **geological news** (25 %) — proceedings, reviews and coming events, with provisional programs; **synoptic articles** (20 %) on a wide range of Earth Science subjects; **book reviews** (25 %); **society activities** (10 %); **news of organizations** (10 %); **calendar** of scientific events (10 %).

A free example will be sent on receipt of an addressed adhesive label.

GEOCHRONIQUE
bridges the gap
between geologists
everywhere

1985 subscriptions

France 130 FF
Other countries 160 FF

Phase, send your cheque,
made out to

« Société Géologique de
France »

to the following address :

Géochronique - Maison de la Géologie
77, rue Claude-Bernard - 75005 Paris - France

JUST PUBLISHED

International Union of Geological Sciences

Publication Number 18

REMOTE SENSING FOR GEOLOGICAL MAPPING

Edited by Paul Teleki (U.S.G.S.) and Christian Weber (B.R.G.M.)
313 pages (including 25 colour plates), 1984. Published as B.R.G.M. Document 82.

Proceedings of a seminar held in Orléans, France, February, 1984, to review the geological applications of the latest technologies of remote sensing, as the basis for a new IUGS-Unesco program. Case histories (in English with French abstracts) deal with the

Order from:
Episodes, Room 177, 601 Booth Street,
Ottawa, Ontario, Canada K1A 0E8 or IUGS
Secretariat, Geological Survey of Norway,
P.O. Box 3006, N-7001 Trondheim, Norway.
Price US\$33 including surface postage and
handling.

merging and correlation of topo-
graphic, geological, geochemical,
and geophysical data for the
production of base maps, with
spectral techniques for distin-
guishing lithologies; and with
the use of reflectance data and
other botanical indicators for
identifying bedrock units.

or: B.R.G.M., B.P. 6009, 45060 Orléans
Cedex, France. Price 300FF plus
30FF postage.