Extra-terrestrial impacts: the record and effects

Grieve, Richard A.
Earth Sciences Sector, Natural Resources Canada, 588 Booth Street, Ottawa, ON K1A OY7

Planetary exploration has shown that impact is a ubiquitous geologic process in the solar system and was a dominant process in early planetary evolution. The Earth, however, is the most endogenically active of the terrestrial planets and, thus, has retained the poorest sample of impacts that have occurred throughout geological time. The current known terrestrial sample consists of approximately 160 impact structures or crater fields. There are also some 20 impact events registered as depositional events in the stratigraphic record, some of which are related to known structures. The sample is biased towards young (<200 Ma), large (>20 km diameter) impact structures on the geologically better known cratonic areas. Approximately 30% of known impact structures are buried and were initially detected as geophysical anomalies and subsequently drilled to provide geologic samples.

The character of terrestrial impact structures provide important data for understanding impact processes, as they are the only source of ground-truth data on the lithological and structural nature of impact craters in the third dimension. In the geologically active terrestrial environment, anomalous quasi-circular topographic, geologic and/or geophysical features, however, do not automatically equate with an impact origin. Specific samples must be acquired and the occurrence of shock metamorphism, or, in the case of small craters, meteoritic fragments, must be demonstrated before an impact origin can be confirmed. Terrestrial impact structures result in unusual local geologic conditions, which can lead to the concentration of natural resources, such as minerals and hydrocarbons; in some cases, the economic deposits are world-class, such as Sudbury, Vredefort and the Campeche Bank oilfield. Impacts are highly transient, extremely high-energy events that can affect Earth systems. For example, a major impact on the proto-Earth is currently the best working hypothesis for the origin of the Earth's moon. In more recent geologic time, the Chicxulub impact structure in Mexico was most likely responsible for the global mass extinction of the biosphere, at the Cretaceous-Tertiary boundary, 65 Ma ago. Such events occur on time-scales of hundreds of millions of years. More frequent and smaller events occurring on the scale of less than a million years represent a long-term threat to human civilisation.

Atlantic Geology, 2003, Volume 39, Number 2