Meteoritics clues to the origin of the Solar System

Dr Alex Bevan

Monday 15th June 2009, ninety people (RSWA members, their families, interested scientists, and members of the public) attended the fourth in the series of RSWA-hosted events Celebrating the International Year of Astronomy 2009 to hear Dr Alex Bevan, Curator of Meteoritics at the Western Australian Museum deliver a well-illustrated and informative talk on “Meteoritics: Clues to the origin of the Solar System”, exploring the questions what are meteorites made of, where do they come from, how did these materials form and what do they tell us about the nature of the infant Solar System.

A description of the Solar System, which consists of the rocky inner planets and the outer gas giant planets, with Earth being geologically the most active. The Moon provides a picture of the amount of meteorite bombardment that has taken place since its formation, and the Earth can be assumed to have a similar history but with its active geological processes earlier meteorite record and crater history have been erased. Some of the clues to the early history of the Solar System, and particularly planetary development (at least for Earth) lies within the oldest rocks on the Earth, e.g., rocks 4 billion years old in Canada, and the zircons 4.4 billions years old at Jack Hills, but to develop an understanding of the planets and materials outside of the Earth and to examine some of the original material of the Solar System we look to meteorites. Many meteorites are 4.56 billion years old and some of these materials appear to have remained relatively unaltered since their formation. Mostly debris left over after the formation of the planets, meteorites, like messengers across space and time, carry to Earth a unique record of the birth of the Solar System, and the history of the Solar System and other Solar System bodies.

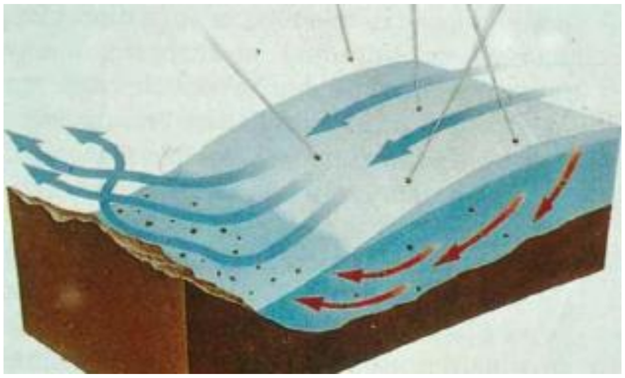
Modern techniques (All Sky Cameral Network ASCN) has added extra dimensions to the science of meteoritics with rotating camera and all sky array of camera networks scientficts have been able to locate meteorites, determine rates of descent, and through triangulation their direction of descent and hence source.

For instance, it appears that a dominant sourcof meteorites is the asteroid belt. Thus, the use f the ASCN has vastly increased the recovery of meteorites – from tens to thousands. Alex then described the relatively recent discovery that with meteorite falls and ablating ice the Antarctica has become an area for recovery of vast numbers of meteorites (e.g., 40,000 recovered). Similarly, the desert regions, such as the Nullarbor and the Sahara, provide vast fields where meteorites are exposed on the surface of vegetation free landscapes. In contrast to Antarctica the desert regions have been accumulating falls for 10,000 years.

Camera used in all the sky imagery (part of ASCN)

Track of meteor against start field - information gained includes rate of decent, and source direction.

Collection techniques using the ASCN and the focus on polar ice sheets and deserts has resulted in a large collection of meteorites for study. In terms of meteorite types, Alex described them as fragments of rock (stony meteorites), metal (iron meteorites), and mixtures of rock and metal (stony-iron meteorites). The stony meteorites are chondrite-bearing, or achondritic (and similar to Earth's igneous rocks).



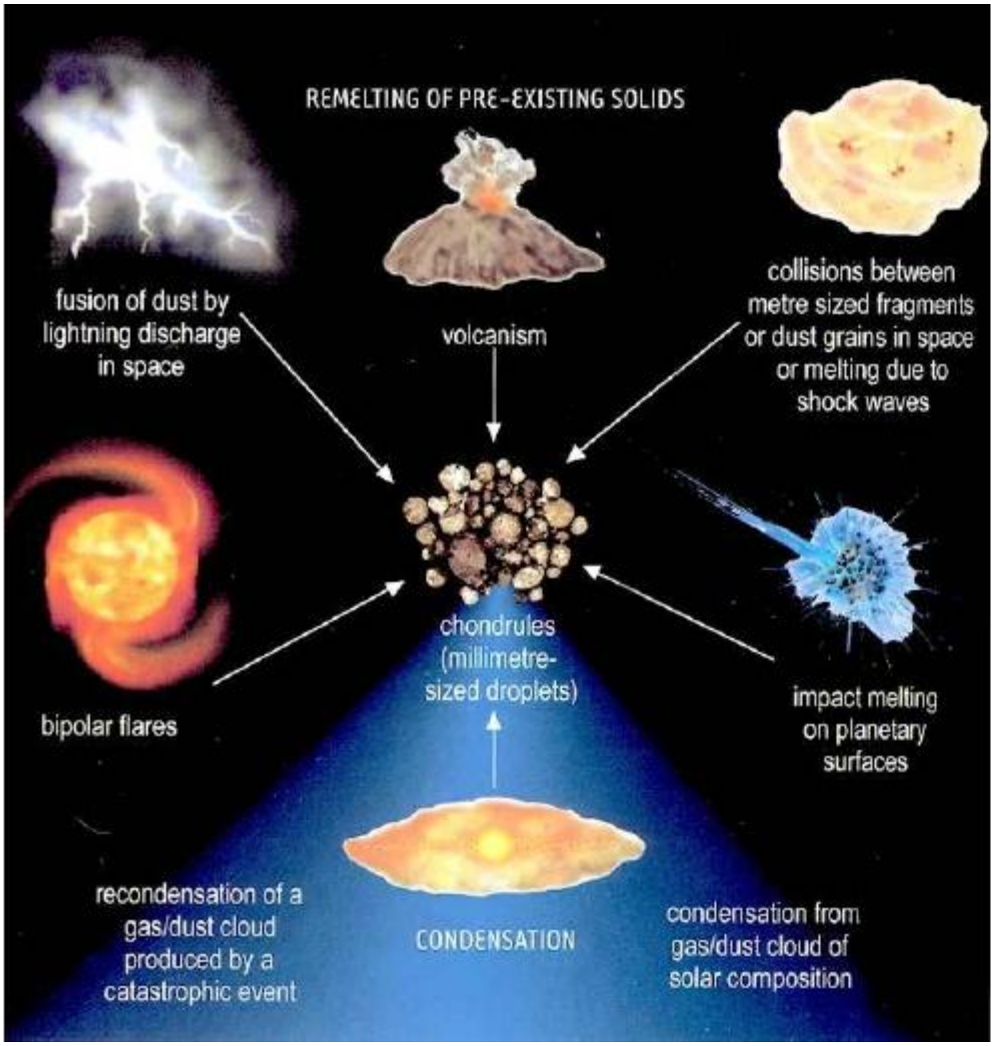
Process by which meteorites falling on the Antarctica ice sheet are concentrated.

Meteorite at the surface of an ice sheet.

The Nullarbor Plain - ideal for locating meteorites.

A focus on mineral composition, inter- and intracrystal textures, and composition relative to the Earth, Moon, other Solar System materials, and the Sun's photosphere, as well as their trajectories and orbits, provides insights into meteorite origins and history. There has been focus on chondritic meteorites because these are primitive, and relatively unaltered and provide the deepest insights into the early history of the Solar system. Essentially, it is accepted that chondritic meteorites compositionally have not changed since their inception. Several types of chondritric material are recognised in the compositional comparisons: High iron-bearing chondrites (notated as H), low iron-bearing chondrites (notated as L), and carbonaceous.

The correlation of composition of carbonaceous chondrites with the Sun's photosphere shows that these meteorites are derived from the Sun. Elemental composition shows meteorites are primitive materials not originating from the Earth.



Multiple and complex origins of chondrules.

Alex summarised his presentation with the history of the Solar system as determined by information from Earth, the Moon, and meteorites.

(a) 4.6 billion years ago there was fragmentation and collapse of the solar nebula, which condensed rapidly and aggregated together to form planets; (b) the next stage was dominated by impact processes – a very important phase in the formation of the Solar System; (c) the Sun purged volatile matter from the inner planets (up to the orbit of Jupiter), and accreting onto Jupiter which then became a giant gravity filter; (d) aggregation; and (e) mutual collisions of inner solar system material resulted in the inner solar system planets and asteroids.

The Early Solar Systen (artist's impression)