

METEORITES:

You may not go into outer
space but outer space
could come to you!

by

Martin Keys

(Woking U3A Astronomy Group))

Section 1

Introduction

What is a Meteorite?

A **meteorite** is a solid piece of debris from outer space that enters the atmosphere and survives its fiery passage to reach the surface of the Earth (or any other planet).



Related useful definitions

- **Meteoroid:** Small body of matter moving in the solar system that would become a meteor **if it enters the atmosphere** of a planetary body.
- **Meteor:** Small body of matter from outer space that enters the atmosphere, becomes incandescent as a result of friction and **appears as a streak of light.**
- **Meteorite:** A piece of rock or metal material that has **fallen to the surface** from outer space as a meteor.

How old are Meteorites?

- Isotope dating of Meteorites reveals mineralogical ages of about **4,600 Million years**. This is as old as the oldest dated Moon rocks and equal to the calculated age of the Earth (and presumably the other planets).
- Some are thought to be from primordial planetary materials (from when the Universe formed). However the diversity of types of Meteorites precludes their origin being solely from this source.
- Most Meteorites were probably generated much later when small already formed bodies in the asteroid belt collided and broke up, into smaller pieces.

Section 2

Main Types of Meteorite

There are 3 main types of meteorites

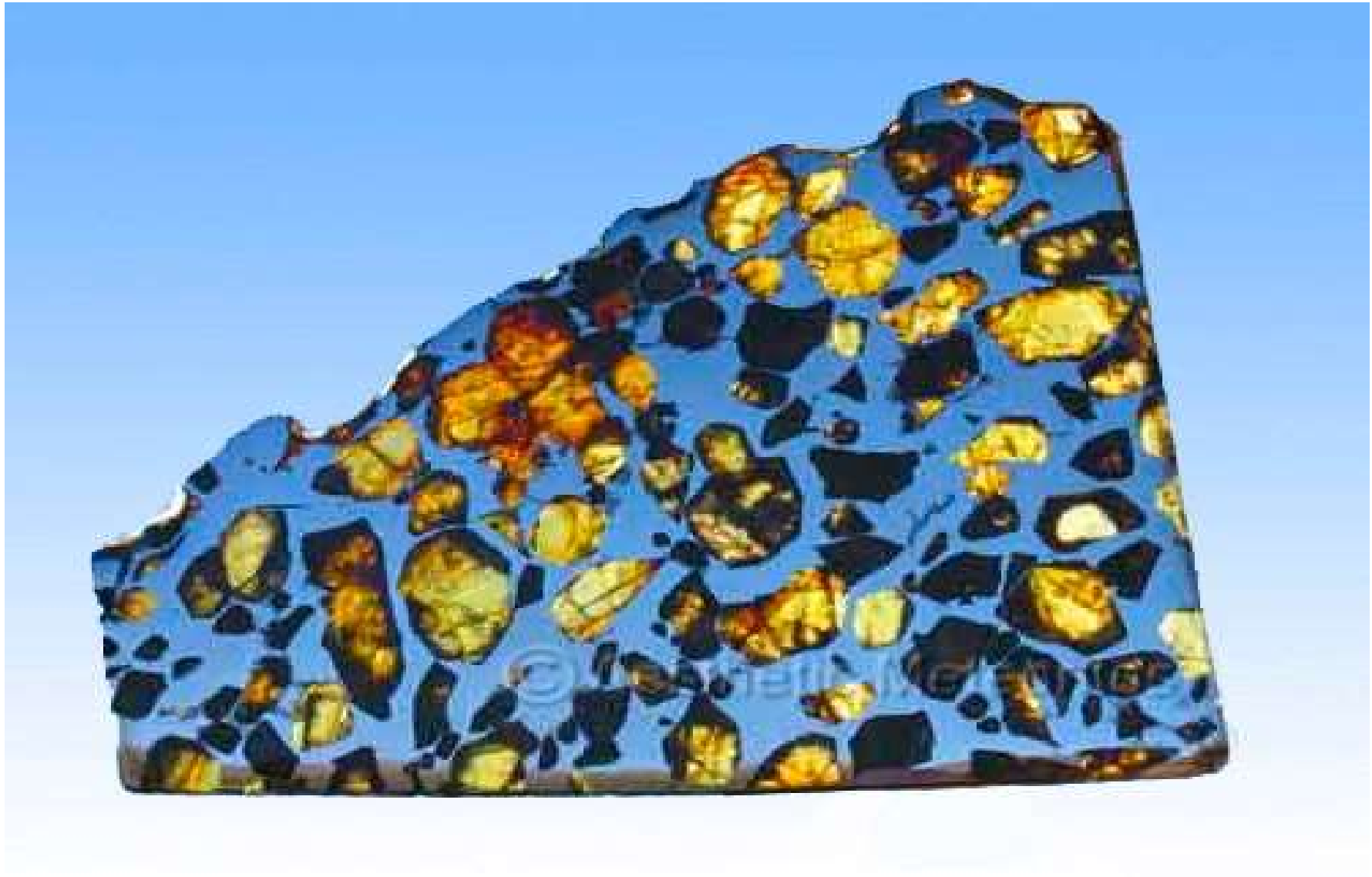
- **Iron Meteorites:** mostly metal (mainly an iron-nickel alloy; up to 20% nickel) [5.7% of obs falls]
- **Stony-Iron Meteorites:** which have nearly equal amounts of metal (iron-nickel) and silicate crystals [1.5% of obs falls]
[There are two types: **Pallasite** and **Mesosiderite**.]
- **Stony Meteorites:** mostly silicate minerals [92.8% of obs falls]
[There are two main types : **Chondrites** and **Achondrites**]

N.B. Each can be further split into more classes/types depending on their mineral/structural make-up.

Iron Meteorite



Stony-Iron: Pallasite



Stony Iron: Mesosiderite



Main Stony-Iron and Stony types

- **Pallasites** are composed of a network of nickel-iron metal in which are set crystals of silicate (stone).
- **Mesosiderite** are composed of broken fragments (roughly centimetre-sized) a mix of silicate (rock) and metal cemented together by a finer material.
- **Chondrites** are some of the most primitive and pristine rocks in the solar system (the material from which it formed)
- **Achondrites** include material from asteroids, Mars and the Moon. They are made up of igneous (volcanic rock) and aid our understanding of the formation of terrestrial planets.

Stony Meteorite: A discovery in Wiltshire

February 2012

“200lb rock that sat on the doorstep of a stately home for 80 years revealed as biggest meteorite ever to fall in Britain”

- The 200lb rock, which is 1.6ft long (and roughly round) is thought to have landed on Earth 30,000 years ago.
- It is four times bigger than any other British meteorite.



Tektites

- Tektites are small (generally a few mm to a few cm) fragments of dark glassy material.
- Once thought to be meteorites themselves they are now believed to be formed by the fusion of materials due to the heat of a meteorite's impact.
- The majority of known tektites occur in a few geographically extensive strewn fields: Australasian; Indo-China; Central European; Ivory Coast, and North American.

Tektites come in a range of shapes



Section 3

Meteorite Falls

All claimed (30) meteorite falls (E & W)



Substansiated meteorite falls in England

No	Place	County	Type	Sub-Type	Mass	Year
1	Aldsworth	Gloucestershire	Stone	Chondrite	700 g	1835
2	Appleby Bridge	Lancashire	Stone	Chondrite	15 kg	1914
3	Ashdon	Essex	Stone	Chondrite	1300 g	1923
4	Barwell	Leicestershire	Stone	Chondrite	44 kg	1965
5	Danebury	Hampshire	Stone	Chondrite	30 g	Found 1974
6	Glatton	Cambridgeshire	Stone	Chondrite	767 g	1991
7	Hambleton	Yorkshire	Sty/Irn	Pallasite	17.6 kg	Found 2005
8	Hatford	Berkshire	Stone	Unclassified	29 kg	1628
9	Lauton	Oxfordshire	Stone	Chondrite	1060 g	1830
10	Middlesbrough	Yorkshire	Stone	Chondrite	1600 g	1881
11	Rowton	Shropshire	Iron	Iron	3.5 kg	1878
12	Stretchleigh	Devon	Stone?	Unclassified	10.4 kg	1623
13	Wilsford-cum-Lake	Wiltshire	Stone	Chondrite	92.75 kg !	Re- Found 2012!
14	Wold Cottage	Yorkshire	Stone	Chondrite	25 kg	1795

The Winchcombe Meteorite

- At 22:00 Hrs on Sunday **28th February 2021** a sonic boom across Southern England and a spectacular streak of light lit up the sky
- This marked the disintegration in the atmosphere of a meteor but some fell to Earth; on a property in **Winchcombe** Gloucestershire.
- It was **Stony meteorite** (Carbonaceous Chondrite) the recovered material weighed just over **300g**.
- The meteor had been **closely tracked (30k mph)** and lead to rapid identification of the fall area and quick recovery of an almost uncontaminated meteorite.
- **Pristine condition**, thanks to early recovery/correct handling.
- The NHM said they are comparable to samples returned from space missions in both quality and quantity (e.g. Hayabusa2 and OSIRIS-Rex).

Section 4

Tracking Meteors, NEO etc

Recovering Meteorites

- Historically most British meteorites have been recovered because they fell in populous areas.
- Of the 14 listed, only the Barwell meteorite (1965) was the subject of a systematic search.
- That was in response to reports of a fall, **not** to the tracking of a meteor.
- Recording the path of meteors against the background constellations to predict their landing point and carrying out prompt searches would enable many more finds. (see "*Astronomy Now*" 07/2004)

Tracking Meteor(ites)in the UK

- **UKMON:** UK Meteor Network - Network of 50+ dedicated meteor monitoring cameras watching for and recording meteors over the United Kingdom.
- Many amateur observers who take a series of digital pictures against the fixed background of stars to determine meteor trajectories, [John will say more]
- **National History Museum (NHM) UK Fireball Alliance** aims to recover freshly-fallen meteorites in the UK.
- Led by NHM staff, **UKFAI** is a collaboration between the UK's meteor camera networks.
- The recent recovery of a meteorite fragment with data from the meteor camera networks is **a first for the UK**

NASA and International initiatives

- **Near-Earth object (NEO)** is any small solar body whose orbit brings it into close proximity to the Earth.
- Current detection can identify objects 100m plus at 100M miles.
- Space based telescopes make detection considerably easier than from ground based ones.
- Awareness of objects 1km or greater is almost 100% **BUT** all objects 20m wide or greater are a potential threat. Although those 20m to 50m don't tend to survive the passage through the atmosphere but air-burst.
- The JPL **Centre for NEO Studies (CNEOS)** computes NEO orbits for **NASA's** Planetary Defence Coordination Office.
- **The NASA Minor Planet Centre (MPC)** – based at Harvard – Records positional measurements of minor planets, comets and outer irregular natural satellites of the major planets. (The MPC is responsible for the identification, designation & orbit computation for all of these objects.)
- **International Space Guard Survey:** This is a **NASA** led International NEO detection initiative

You can also “hear” Meteors!

- Meteor trails – the trails of ionized atoms and molecules seen as visible bright streaks – reflect radio waves that can be broadcast as audible pings.
- These radio wave reflections offer an alternative observation method.
- In particular radio equipment is capable of detecting smaller particles than visual observations
- Furthermore it can be employed during daylight hours or on cloudy nights.

END

Now meet the “cast” !