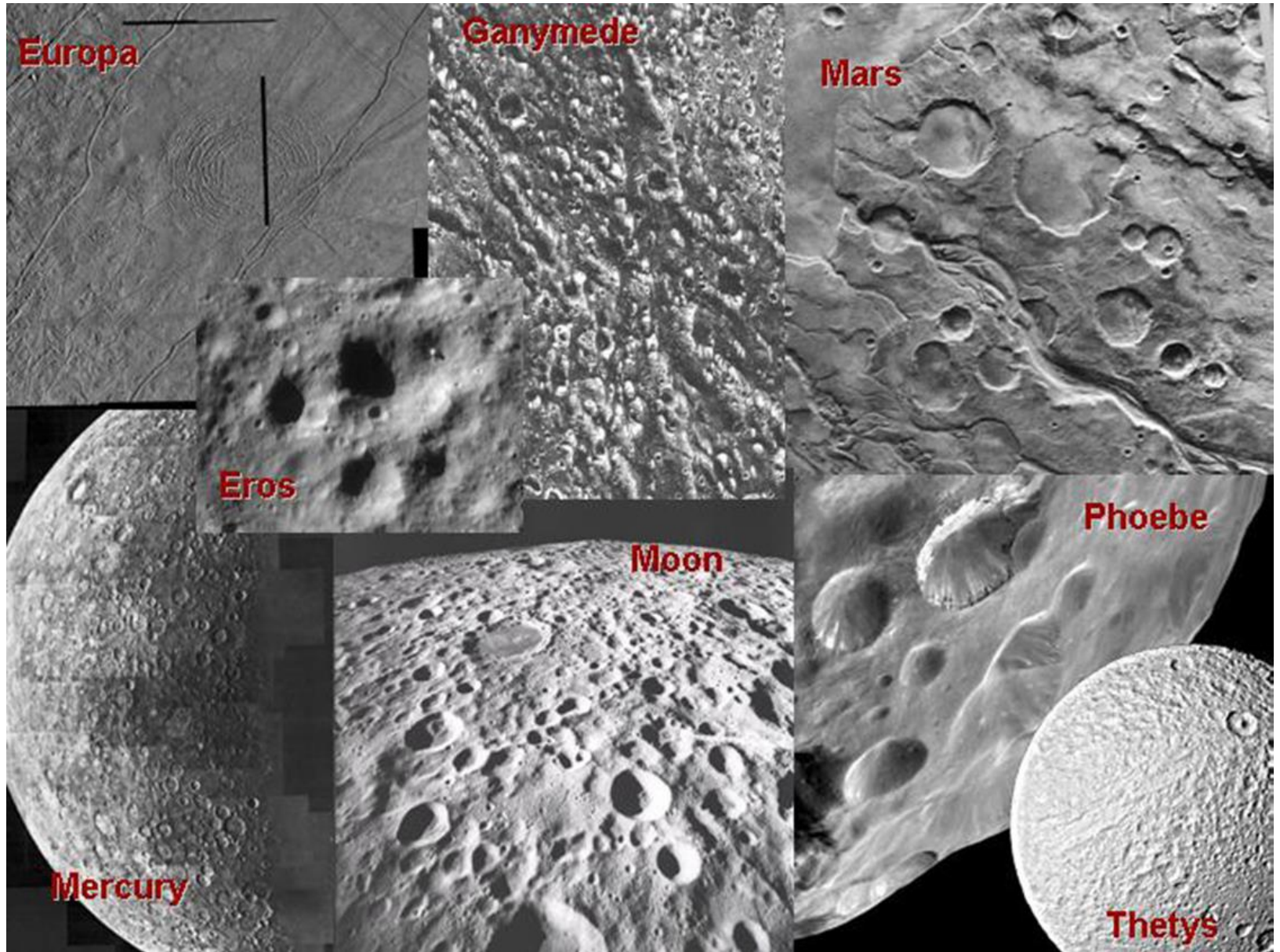


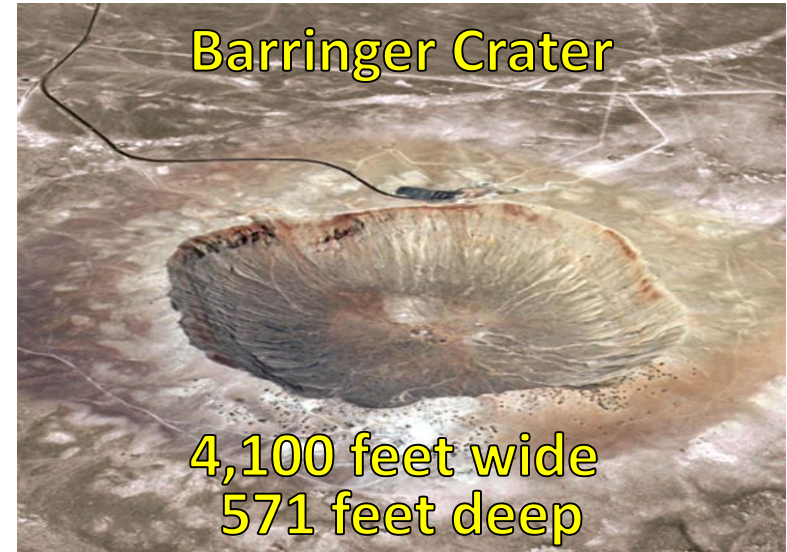
# Little or no atmosphere to protect from the impacts...



# Asteroid Impacts

- Objects with a diameter of **~50 m** (~160 feet) strike Earth approximately **once every 1000 years**:

- **~50,000 years ago: Barringer Crater, Arizona**
- **1908: an asteroid estimated at 50 m across explodes above Tunguska, Siberia, blowing down trees across 2,000 square kilometers and killing a thousand reindeer, but apparently no people. It exploded in the atmosphere so there's no crater.**



- Asteroids with a **1 km** (0.62 mi) diameter strike Earth **every 500,000 years** on average.
- Large collisions – with **5 km** (3 mi) objects – happen about **once every 20 million years**.
- The last known impact of an object of **10 km** (6 mi) or more in diameter was **65 million years ago**...

# Chicxulub Crater

(tip of the Yucatán Peninsula, Mexico)

One of the largest confirmed impact structures on Earth: more than 180 km (110 mi) in diameter and 20 km (12 mi) deep.



- The impacting asteroid was **at least 10 km (6 mi)** across.
- Widely considered by paleontologists the area of impact for the K-T extinction bolide **65 million years ago (mass extinction of some three-quarters of plant and animal species on Earth - including **all non-avian dinosaurs**)**.



# Meteoroids

- Parts of comets or asteroids, 'space collision debris' that range in size from dust to around 10 meters across.
- Many meteoroids are on a collision course with the Earth.
- **Several hundred tons** of meteoroids enter the Earth's atmosphere **each day**. Most of these are very small pieces (milligrams) that burn up quickly in the atmosphere and never reach the surface.



- About **once a year**, an **automobile-sized meteoroid** hits the Earth's atmosphere, creates an impressive **fireball**, and burns up completely before reaching the surface.
- Even if a meteoroid hits the ground, usually nothing happens!

# What causes meteoroids to burn in the atmosphere?

- The fastest meteoroids travel through the Solar System at a speed of  $\sim 42$  km/sec ( $\sim 26$  mi/sec).
- When a meteoroid enters Earth's atmosphere, it can travel **as fast as 70 km/sec**, much faster than a bullet leaving a gun barrel!



- **Air** in front of meteoroid gets rapidly **compressed**: as it compresses, it **heats** and causes surface of the meteoroid to **melt** (producing **glow**) and **vaporize**, and sometimes **disintegrate** (that is, **blow up**).

# Meteorites

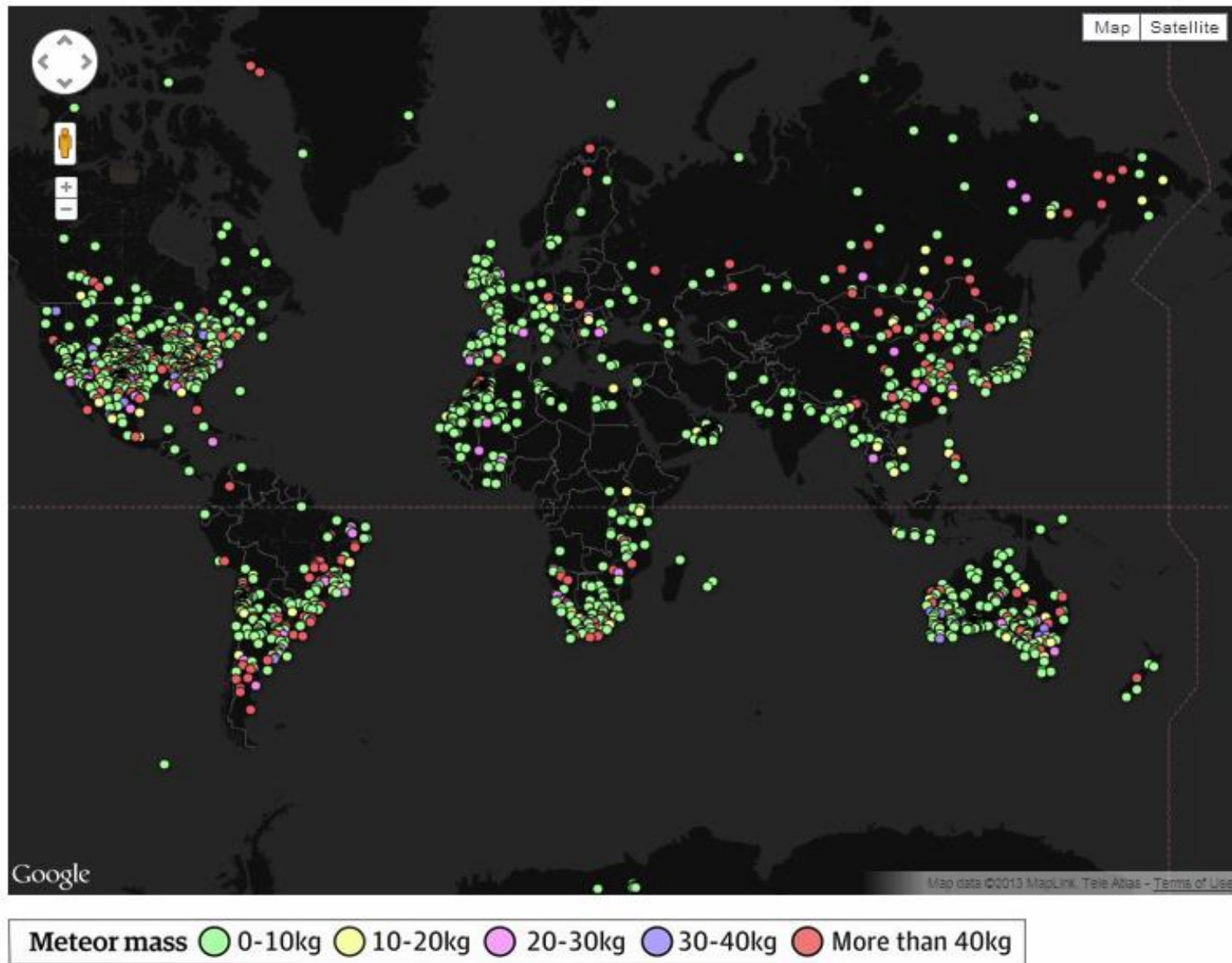
(“survivor” meteoroids)

- Meteorites that are observed as they fall through the Earth’s atmosphere and later recovered are called ‘falls’, all others are called ‘finds’.
- Around 500 meteorites reach the Earth’s surface every year but of those only around 5 ever make it to scientists for study.
- To this date there have been **thousands of collected ‘falls’** and **~50000 ‘finds’**.

*A polished slice of the Fukang Meteorite, China 2000 (olivine in nickel-iron)*



# Where are meteorites found?



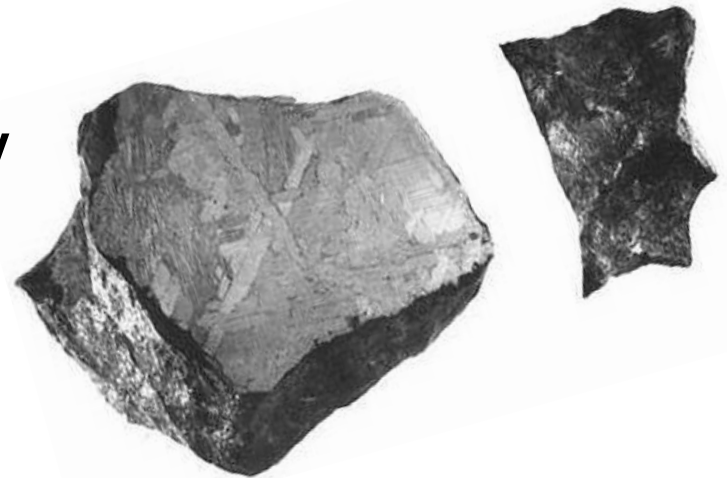


# Meteorites Composition



- **Stony**
  - Look like ordinary earth rocks at first glance, but the outsides of the rocks look melted. **Most meteorites (93%) striking the Earth are stony.**

- **Irons**
  - These dark grey, metallic, and very dense meteorites are unlike any earth rocks that you have ever seen. **Five percent** of meteorites striking the Earth are **irons.**



- **Stony-Irons**
  - These meteorites have clumps of both iron and stone.



# Hoba Meteorite



- Discovered in Namibia just before 1920 by land owner.
- Fell to Earth more than 80,000 years ago.
- Has never been moved from where it fell, now a tourist site.
- Reduced due to erosion, sampling, and vandalism, its **remaining mass** is currently estimated at just **over 60 ton**.
- The **largest known single piece meteorite** (~3 m across).
- The **most massive naturally occurring piece of iron** known at the Earth's surface.