PROBING THE DEAD COMETS THAT CAUSE OUR METEOR SHOWERS. P. Jenniskens, SETI Institute (515 N. Whisman Road, Mountain View, CA 94043; pjenniskens@mail.arc.nasa.gov).

Introduction: In recent years, a number of minor planets have been identified that are the parent bodies of meteor showers on Earth. These are extinct or mostly-dormant comets. They make interesting targets for spacecraft reconnaissance, because they are impact hazards to our planet. These Near-Earth Objects have the low tensile strength of comets but, due to their low activity, they are safer to approach and study than volatile rich active Jupiter-family comets. More over, fly-by missions can be complimented by studies of elemental composition and morphology of the dust from meteor shower observations.

Meteor shower parent bodies: The first object of this kind was identified by Fred Whipple in 1983, when he realized that 3200 Phaeton moved among the Geminids [1]. The association was long disputed because the minor planet had the taxonomic type of an asteroid (type B) and the meteoroids had a relatively high density. Both aspects are now thought to be due to the low perihelion distance (q = 0.14 AU) of the orbit. At perihelion, they are heated to ~700 K, causing sintering of the dust grains into more solid particles.

The uncertainty was resolved in 2004, when a second such "asteroidal" looking minor planet 2003 EH1 was identified as the parent body of the Quadrantid shower [2]. The unusually steep inclination of the orbit (72^o) and its orientation made a chance association unlikely (chance of about 1 in 10^5). The stream is massive and about 500 years young, based on the dispersion of orbits. Given the lack of current activity of 2003 EH1, the stream was probably formed in a fragmentation event about 500 years ago. Chinese observers noticed a comet in A.D. 1490/91 (C/1490 Y1) that could have marked the moment that the stream was formed.

In 2005, a small minor planet 2003 WY25 was discovered to move in the orbit of comet D/1819 W1 (Blanpain). This formerly lost comet was only seen in 1819. A meteor outburst was observed in 1956, the meteoroids of which were traced back to a fragmentation event in or shortly before 1819 [3]. It was subsequently found that 2003 WY25 had been weakly active when it passed perihelion [4].

Since then, the Daytime Arietids have been found to be associated with the Marsden group of sungrazers [5], the alpha-Capricornids are associated with 2002 EX12, a weakly active comet at perihelion [5], and the Sextantids are from 2005 UD [6]. In all cases, the association has been established with reasonable certainty due to unusual orbital elements or the observation, or because of observed cometary activity from the proposed parent body. The list is increasing steadily. The observed meteor showers all have a relatively recent origin. The Andromedids date from 1843, the Phoenicds from 1819, the Quadrantids from 1490, the Daytime Arietids from a time after AD 1059. The Geminids date from around AD 1030. These dates define a historic event, the scars of which may still be recognized on the minor planet.

Type of fragmentation: Based on the number of showers of this type, this meteoroid stream formation mechanism is more important than water vapor drag of dust particles proposed by Whipple in 1950.

The most pressing issue is to discover the mechanism that is behind these fragmentation events. One clue from the meteor shower observations is the fact that the total mass of the meteoroid stream is often of the same magnitude as that of the remaining minor planet. That suggests that the fragmentation is due to the shedding of cometesimals, rather than catastrophic fragmentation.

The first direct evidence of this formation mechanism may have been detected during the 9P/Tempel 1 encounter of NASA's Deep Impact mission. Two regions on the comet surface were identified as the potential scars of such cometesimal shedding, each representing the loss of an ~0.5 km fragment [7]. It was later found that at these sites water ice is exposed near the surface [8]. The ice can be due to recondensation of a seep from a reservoir below the surface. The shedding of a cometesimal could have brought the reservoir to the surface, covering fresh ice by fallen back debris.

In this light, many of the surface features of other comets, such as 81P/Wild 2, are probably the result of cometesimal shedding.

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Additional Information: More on this in: P. Jenniskens, 2006. *Meteor Showers and their Parent Comets.* Cambridge University Press (in press).