Student questions: Dr. Catherine Macris colloquium on "Seconds after Impact: Insights into Impact Processes from Ultra-High Temperature Experiments"

1/26 /22

Question 1: What is the fO2 that is a possible source of incorrect replication in the experimental tektiles?
I'm not aware of a study that defininitively reports the fO2 of impact plumes, but there is some evidence that it is relatively reducing. In a study by Schreiber et al. (1984), it was reported that essentially all the iron in tektites is Fe(II). Since we don't know what the fO2 of the impact was, we can't attempt to recreate it in the lab.
Question 2: Why do certain tektites collect in some area over others? (Australia vs. Phillipines vs. Indochina, etc.)
Tektites are collected either where they landed originally or where they have been subsequently transported to in the time since the impact occurred. They land in different places due to the fact that each tektite has a unique ballistic trajectory.

Question 1: How can we presume or recognize impacts on the earth's surface but not on the oceans, for example?
We can recognize impacts on the ocean floor if we have found evidence of them. The Chicxulub crater, for example, was discovered in the 1970s by gravity data collected from a ship that was searching for oil in the Gulf of Mexico.
Question 2: What other types of impacts are occurring or have occurred on Earth, or is it just the one described in the presentation?
Earth has been bombarded by innumerable impactors of various natures.

Question 1: It was mentioned that impacts could be responsible for bringing important compounds for life like water (ice), organics, etc, but what does the high temperatures/pressures of these impacts do to the compounds being carried by the impact material?
As asteroids and comets bombarded the young, hot Earth, water and the hydrogen in them would have boiled off into space. As Earth cooled over time, water from these collisions could have condensed onto Earth.
Question 2: If high temperatures can affect the volatility of copper and zinc in ways that one cannot use the condensation temperature to predict, could this also be true for high pressures?
I think so!

Question 1: If pieces of the meteorite/impacting object mix with the molten ejecta during the impact, how might they affect the composition and physical properties of the resulting tektites?
According to hydrocode models, the impactor will be completely (or nearly so) vaporized upon impact. That vapor could eventually condense elsewhere or onto cooling melt parcels, but it will be so diluted that its contribution to tektites is very hard to find. There is some evidence of Os anomolies in tektites that has been attributed to the impactor. There is a good discussion of this topic on p. 144-145 of Koeberl (1994).
Question 2: Is it possible to determine any information about the impacting object (such as the type of object, its origins, or its composition) from tektites if no other physical remains of the impact are available?
See answer to Question 1.

Question 1: How many different types of tektites are there (such as the muong nong,for example)?
There are 3 basic morphological types: splashform, layered (Muong Nong), and ablated. Microtektites are sometimes considered there own category, but they are sometimes considered a subcategory of splashforms.
Question 2: What are the qualifications to be a major tektite strewn field?
This question may be answered differently by different people. In my mind, a major tektite strewn field is one that the literature historically agrees is definitively a strewn field. I'm open to the idea that there are unrecognized strewn fields, but I don't attempt to answer that question in my research (so far). This recent paper by Rochette et al. (2021) argues that there are many previously unrecognized strewn fields.

Question 1: Is there a way to couple the impact models with climate change models ?
Not sure exactly what this question is asking. I think you might be asking if large impacts have been linked to climate change. This New Scientist article describes such a scenario.
Question 2: Besides tektites, and craters, is there any other way of identifying a high velocity impact?
Yes, high pressure mineral polymorphs such as stishovite are also used.

Question 1: "Earth doesn't get struck like it used to for mass extinction from meteors." We would be able to see the meteor coming before it hits, but how far in advance can we see something coming toward earth, and is there a possibility something could travel so quick we would only have days of notice?
The Near Earth Object (NEO) Observations Program is a NASA initiative to search for and characterize NEO's. The Planetary Defense website's FAQ page will be able to answer your question as well as is possible.
Question 2: How much does a pyrometer cost, and is it the software, or set up that is most expensive?
A pyrometer (device used to measure temperature in experiments) costs several thousand dollars, but the entire levitation system can cost several hundred thousand dollars, depending on specifics.

Question 1: How does the levitation machine keep your sample centered with the laser once it becomes molten?
The flow of gas from the conical nozzle is what keeps the sample centered.
Question 2: Can you recommend a place to learn more about the levitation experiments and see some videos?
You can watch the Science Channel episode that filmed at my lab here, though it costs $1.99 per episode to view. This paper by Benmore and Weber (2017) is a nice explanation. I was also informed after my talk that Alex Navrostsky has recently moved her levitation furnace from UC Davis to ASU! You could contact her group to see one in real life once it is set up and operational.

Question 1: When studying interdiffusion between silica and felsic melts of natural tektite, how important is constant pressure compared to constant temperatures?
I don't know that I could say which is more important. It would depend on the relative differences. They both matter!
Question 2: How were the parameters set for the boundary layers for the aerodynamic levitation laser heating furnace.
I'm not exactly sure what what this question is asking. We can't control the boundary layers in experiments. They will be the result of all combined experimental conditions.

Question 1: On one of the earlier slides, it was noted that some amino acids may have arrived to Earth on extraterrestrial bodies, how would these compounds not be denatured by the high temperatures and pressures as noted in following slides?
See answer on page 1 to similar question.
Question 2: What are some of the leading theories as to why the Australasian tektite spray area is so much larger and, respective to the other tektite zones, an odder shape – like what caused it to have two zones of no tektite material?
There is a theory that this impact was caused by two bolides, although it is not widely favored. The large area is generally attributed to the size of the impact, angle of impact, and nature of impactor and target material. It is also the youngest strewn field, so some of this could be a sampling bias.

Question 1: Why did the glass sphere go from having lots of the texture on them to having little to none after having the laser on it for 120s?
Because at longer heating durations, the silica melt parcels will have time to completely diffuse into the surrounding melt, until they are essentially "dissolved" away.
Question 2: How do you manage having so many uncontrollable variables in your experiments?
We do our best to control the variables we can and try to characterize any effects of the ones we can't.

Question 1: How long does it take for tektites to solidfy once they hit the ground?
Most tektites solidify in mid-air. The cooling process will depend on the peak temperature, size of melt parcel, and temperature gradient.
Question 2: Have we found all of the major impact sites on the Earth's surface, or is it possible that there are still potential impact sites that haven't been documented yet?
There are most certainly impact sites that we have not documented yet.

Question 1: How common is it to find vitrified glass from meteor strikes in Arizona?
There are impact glasses associated with Barringer crater, but they are not classified as tektites because of the strict definition of a tektite (must be distal ejecta).
Question 2: Could the impact of a meteor cause slip in active faults?
I think it could if it was big enough and landed in the right spot.

Question 1: Would it be possible to introduce estimated atmospheric conditions with similar velocity to the cooling magma balls?
We can control the atmosphere in the levitation chamber by our choice of levitation gases.
Question 2: How does this research improve our understanding of crustal thermal dynamics?
I don't know how my research directly contributes to that.

Question 1: How can you determine whether two tektites came from the same impact event?
Composition and nature of impact products as well as age dating.
Question 2: Why do tektites have such a consistently rhyolitic composition?
Because tektite form from mostly upper crustal sediments which approximates rhyolite in terms of composition.

Question 1: It looked like there were tektite strewns that were located in the ocean area, have you noticed any movement of the tektites due to the ocean current or natural phenomena and is this taken into account in the research?
Tektites collected in the ocean are from drilled sediment cores.
Question 2: Whats the furthest distance you know of a tektite being ejected?
>12,000 km

Question 1: Are there a lot of tektites on the moon and can they be used to understand the late heavy bombardment?
There are impact glasses on the moon, although it might not be technically correct to call them 'tektites'. Zellner (2019) is a great resource to learn about lunar impact glasses.
Question 2: Can we find tektites on earth and correlate them to tektites on the moon to further understand the late heavy bombardment?
Not sure what is meant here.