

ExMAG Fall meeting notes

Wednesday, October 12th, all times Eastern

11am: Welcome, Barbara Cohen, NASA GSFC

- Attendees are bound by the LPI Code of Conduct - please treat everyone with respect, be considerate, and communicate openly and thoughtfully. Be mindful of critiquing ideas, not people. Do not screenshot or share the screen without permission from the speaker. What is said here, stays here (Vegas rule).
- ExMAG membership - Steering committee of Barbara, Francis, Jeff and Kathleen. There are also subcommittees, and we will be recruiting for those shortly.
- Please send any corrections or comments for the website to us. We also have a Twitter account
- Two White Papers were submitted since the Spring meeting
- SPD-41 - feedback was given to NASA. The full committee discussed this, and there were public meetings. Overall, we have a lot to do as a community with regards to data management, especially with regards to the sample analysis community. There will be a session on this tomorrow to discuss it further.
- The ANGSA-2 solicitation will open soon - ExMAG recommends that the sample suite be expanded.
- Our Spring meeting findings for the PAC: Around the No Due Date programs, the community doesn't understand when deadlines are happening, so clarification of this would be helpful. Also, there are challenges for ANSMET (more on this later in the meeting), and also NASA should continue to work to find ways to work with China (for example the Chang'E samples).
- If you have questions for NASA, have them ready now.
- There will be a poster session in Gather.town - please attend that, and consider submitting a poster for future meetings.
- There will be presentations at this meeting on ANSMET, nomenclature, IDEA, Samples return, the Decadal Survey, Data archiving, and finally there will be a Discussion and Findings session.
- Please be respectful of other speakers' time. Please do not screenshot slides. Questions can be submitted via Slido - questions will be moderated, and can be upvoted.

NASA Programmatic Updates - Barbara Cohen

11.15am: NASA HQ Briefing, Jeff Grossman NASA

- Jeff Grossman - liaison to ExMAG, program scientist. Astromaterials, program scientist for Osiris-Rex.
- Programmatic changes to programs that deal with astromaterials will be presented in this talk.
- The current portfolio, solicited every year:
 - Perennial programs: EW, SSW, ExoBio and Mars (astromaterials analysis)
 - Special programs: for mission-participating science (Osiris-Rex, Hayabusa, ANGSA, MMX PSP)
 - Legacy Programs: Cosmochemistry, LASER, origins of solar systems, Planetary Geology and Geophysics
 - Also mission portfolios (not listed)
- Changes to programs that have occurred recently:
 - Dual anonymous peer review (not yet implemented in perennial programs, but was done in participating programs). Plan is to continue doing this for PSP programs in the future
 - Still evaluating DAPR for panel review process
 - No deadline (No Due Date - NoDD) - all perennial programs are NoDD now. This started with ROSES-21, and is in a 3-year pilot process. No interpretations of how well it is working will be given until the pilot period is finished. The NoDD pilot coincided with Covid, so it's difficult to compare with previous submission rates. Proposal pressure is currently low - about $\frac{1}{3}$ the number of proposals have been received compared to ROSES-2020. The chart shows a spike at the end of the ROSES 2021 year - this is community-driven. People are choosing this as a deadline, but it is not necessary - submissions are always open.
- Support for Astromaterials Research: Jeff has picked a couple of years from before the present era (2010 and 2015), and three recent years.
 - He looked at all of the proposals selected and funded, and decided which contained a heavy sample-analysis component (no sample-analysis adjacent topics, such as modeling or instrument development). 2022 is not included as it is not over yet.
 - The numbers are however fairly consistent, at around \$20 million per year. Some programs (e.g. LARS) have gone down, while others have come in (e.g. ANGSA). SSW appears to be gradually increasing. You should note that there has been inflation, so flat funding is actually a decrease.
 - There is also ISFM work at NASA centers in 2019-2021 that is on top of this.
- Jeff also shows this data in the form of a bar chart.

- Instead of dollars, the data can be looked at in the terms of activity (proposals). Instead of a constant total, there is a significant drop in terms of supported activities. This is mostly accounted for by inflation. If you include ISFM money, that accounts for ~25-27 ROSES awards not being funded.
- This data is also shown in bar chart format, and shows which Astromaterials are being studied by different proposals.
 - Asteroids (meteorites, IDPs etc) make up the major element for support, mostly in EW. The grey bar is lunar - Apollo and lunar meteorites, including ANGSA.
 - The pink bar shows projects focusing on Mars, and is decreasing. The reason is not clear.
 - At the top are LARS programs - Stardust and Genesis. Driven by proposal pressure, not programmatic pressure. Hayabusa (red bar) will move to LARS.
- Forecast for future funding:
 - No anticipated changes in the core programs.
 - Proposal pressure is currently low, which means the level of support might change. The low proposal pressure was also discussed recently at the DPS meeting.
 - The LARS program is shifting towards supporting method and instrument development, and will pivot towards ORex in 2024 using the current budget. Samples will become available in Late Spring 2024.
 - Artemis sample science is still in the process of being supported.
 - ORex will be the first team to receive mission support since Stardust/Genesis.
 - Mars sample return science is still in formulation
- Questions?
- Barbara notes that she appreciates Jeff's work on putting this together.
- Q - *Has the overall ROSES budget remained flat over the last dozen years?* Jeff does not have the official numbers, but the budget has gone up in a targeted way. Individual programs fluctuate, and more programs have been added (so individual programs may not have increased). It's fairly flat, unless you add in the budget for centers.
- ExMAG - look at core programs, and targeted programs that have been added
- Q - *Is there any increase in iron meteorite studies (because of Psyche)?* Jeff says no.
- ORex is supporting sample analysis - for how long? The main part of sample analysis is 2 years from the date of return (ORex Phase F). Jeff tried to get an estimate, and it's in the \$5million ballpark.

- *Q - What is the expected time to notification under NoDD?* Metrics on that are 80% notified within 150 days. A lot of things can happen that drive a long time on the tail end (eg PI transfers). This would be consistent with the pre-NoDD days. We got off to a slow start, but are on track for this now.
- *Q - Did you see any shift in sample analysis funding when Mars was added?* That has never happened. The scope of LARS and EW have never overlapped. LARS was formed from the SRLIDAP program, then it was DDAP, then SSAP, and the scope has never overlapped. Jeff does not know the history of the LARS budget as it predates him at NASA.
- Barbara notes that the curators of the Smithsonian have noticed an uptick in requests, but the proposals targeting these samples have not gone in. Jeff is talking about funded work, not the number of proposal submissions - he can't comment on the number of proposals.
- Kathleen reminds everyone that ANGSA-2 Step 1 proposals are due next week.
- Jeff says that instrument development has to be timed carefully - it can be done, but you don't want to develop an instrument that is obsolete by the time the samples are returned.
- Barbara notes that if you have any questions later in the meeting, please bring them to Jeff.

11.45am: NASA Planetary Science Enabling Facilities program update, Aaron Burton NASA

- Initially, he was hoping the first round of PSEF would be done so he could talk about those, but they are still working on them so he doesn't want to preemptively talk about them.
- They are wrapping up PSEF - this has been in the works for a few years, and announcements should be out within the next month.
- They will work with the selected PIs to publicize their work at meetings about the new facility they are setting up, what the capabilities are, how to get access etc. They want the community to have access.
- They will also add this info to Appendix C1 in ROSES.
- For the future, they expect to solicit PSEF Round 2 in 2024. One set will be selected this year, and then staggered over the next couple of years, so it will come around in 2-year cycles.
- The budget is expected to be similar.
- Don't know how many PSEF budgets will be funded - there are currently 3 existing facilities. The current spending is around \$3million, and will increase to around \$5million.

- *Question - are the current facilities carrying on, or will they have to repropose?* They are trying to move these facilities into this cycle. So that all facilities are demonstrating their worth through the peer-reviewed process.
- *Q - this is not the same as PME? Clarify purpose?* Aaron will talk about this further. This is a separate program that will be solicited every 2 years. You can request equipment to start a new facility/buy next-generation instruments, but we also want proposers to be able to get the equipment they need. One thing that has come up is how to propose for an instrument if you're not a facility. Appendix C1 was changed - you can append major equipment requests to any proposal. Over \$50k, those requests will be reviewed. There is not a separate PMS (that used to be C17).
- *Q from Barbara - so PME is still allowable, it's just not a separate call?* Aaron - Yes. If you need a new piece of equipment, decide which program you are submitting to, and check in with the program officer for that program to see what they say.
- **ExMAG action - understand the landscape of where to propose for what**
- *Q - Will different facilities be funded in every round?* Aaron - They want to be more rigorous in reviewing facilities after they are funded, to make sure they work the way they are supposed to. They will review around year 2/3 how facilities are performing. If you are meeting all your bars, you will be directed for reproposing and recompeting. They want competition though so that the community still wants the facilities. E.g from Jeff's talk - people are less interested in Stardust and Genesis. Community needs will change over time.
- *Q from Barbara - questions asked previously about the intent of letters of support that facilities are useful - can you talk about how these letters are used?* Aaron - they view those as one way (not the only way) that there is community demand. They are not required, so lack of letters should not be held against a proposal.
- *Q - If PME have to be attached to a proposal, does that bias against certain proposals?* Aaron - panels are asked to see if the equipment is necessary to complete the work, can it do what they need it to do? Then it's up to NASA HQ to figure out the funding. There shouldn't be a bias against it at the science level.
- *Q - If all PSEF facilities perform well, will no new facilities be funded? If the funding is flat, it will get filled, and there will be no money for new facilities. What is the plan for new facilities?* Aaron - The expectation is that there will be competition every 4 years, and there will probably not be a shortage of ideas, so this will really be up to the review panel.
- *Q - But there are places already funded - if they continue to perform well, how do new places compete?* Aaron - asks Jeff to speak. Jeff - If you're performing well, you don't get a free pass. Existing facilities will have to justify their existence.

Competition. If there is a constrained budget, there will be turnover to meet the needs of the community - they won't be sustained without competition.

- *Q - Statements of commitment don't include letters of affirmation. How do you keep the panel unbiased?* Aaron - there is an order of precedence. First order - C17 can contradict C1, C1 can contradict the solicitation summary. Anything in C1 takes precedent over the guidebook. *Barbara - how do you ignore letters if you've already seen them, and remain unbiased.* Aaron - it's a choice for the proposers whether to include them - this makes it a level playing field. The panels are really notified that the letters indicate a demand from the community. Jeff - there may be details in the letter that speak to things that are merit-based, and that's not allowed.
- *Q - it's hard for a new lab to compete with existing labs - how does the panel take that into account?* Aaron - doesn't think it is as big of an issue as it might seem. The budget has significantly increased so there's a lot of opportunity in PSEF right now. Panels are asked to review the proposals and see how they will meet the community needs - how useful will it be to the community? Specialized facilities can still be funded, but the audience needs to be taken into account.

12.15pm: NASA Planetary Science Division update, Lori Glaze NASA

- Really happy to be here - lots of exciting results!
- Excitement across the whole portfolio of missions - the inner spiral on the slide is Moon and Mars. LRO in extended missions, 9 eclipse missions, several Mars missions are in extended missions. On the outer spiral there's the rest of the solar system. 40 missions on the chart! A lot of these contribute to sample return science.
- DART - an amazing mission by APL, a successful impact on Dimorphos (moon of Didymus). They were able to see the entire asteroid before losing contact. Direct hit, amazing images were collected. Lots of observations were taken from ground- and space-based telescopes. Stuff coming off in the videos is thought to be vapor. There was a debris curtain of fine-grained material being pushed out by solar radiation pressure. Similar features are observed by the James Webb telescope. Yesterday, they announced that the orbital period was changed by 32 minutes +/- 2 minutes - very successful mission!
- Hayabusa samples are being analyzed already. Samples curated here and in the US.
- ORex should arrive Sept 23rd 2023, will land in Utah. The science teams are currently practicing and training for sample handling. New PIs have been selected. Sample catalogue to be published by March 24 2024.

- MMX - collaboration with JAXA, on track for Sept 2024 launch. Studying Phobos and Deimos, then land on Phobos and bring a sample back. PSP - review in progress. First flight of JAXA H3 launch vehicle is planned by the end of 2022.
- Mars sample return - 12 rock core samples collected when the presentation slide was made. Lots of materials from around Jezero crater, lots of organic molecules. Also recently collected 2 more samples - #13 and #14 are on the rover. There was a recent sample-caching workshop looking at these samples to decide if they are scientifically justifiable for eventual return. The decisional meeting is coming up soon (next couple of weeks). Samples are paired - one sample, along with a witness tube, will be left in an area that will be easy to recover samples from, with the other sample kept on the rover. These samples on the rover will eventually be returned to earth. The samples left on the surface are a back-up cache in case anything happens to the rover, and it can't meet the sample return lander.
- Mars sample return is going well - they are moving into Phase B. NASA and ESA are collaborating on this.
- New Frontiers 5: The next call was released Sept 1 2022. They are trying to help people plan, and would also like community feedback for the AO. The AO may not incorporate all the comments, but they'll try to release changes in a timely manner. Estimated draft release: November 2022, final AO: November 2023, Proposal due date estimated March 2024.
- Draft mission themes:
 - Comet surface sample return,
 - Lunar South Pole-Aitken Basin sample return,
 - Ocean Worlds (Enceladus),
 - Saturn Probe,
 - Io Observer,
 - Lunar Geophysical Network.
 - Venus missions are unlikely to receive funding for programmatic reasons - there have been several Venus missions funded recently.
- Decadal Survey was released in April 2022. Initial written and public response is available online. Next meeting in March 2023.
- Shared expectation: Decadal survey included a recommended program and a budget to support this: \$47 billion over a ten-year period. The more modest version is about \$35 billion over a 10-year period. Next flagships - Uranus probe, Enceladus.
- The expected 5-year planning budget shows a substantial shortfall in the near term. This means that the ability to start things quickly may be challenging, and may have to shift to later times.

- Lunar updates: There has been lots of discussion about having a better-formulated strategy for lunar science, competed missions, human exploration etc. There is now a Lunar Strategy team to lay out a framework for the strategy.
- There are several upcoming lunar-focused solicitations.
- State of the profession: there is an entire chapter dedicated to this in the Decadal survey. There's still a lot to do on this front.
- Questions?
- *Q - Could you talk about how Artemis, CLIPS, and PRISM programs are likely to impact upcoming lunar sample return New Frontiers missions (or even lunar IGN mission). There is a STRONG feeling in the community that any lunar sample return mission will be DOA because of those programs.* Lori - This is definitely a community concern. For New Frontiers 5, with the draft parameters, Venus is not included as it will not be on a level playing field. Both Lunar South Pole and Geophysics are included as they are on a level playing field and legitimately considered for inclusion. At this point, she expects lunar payload-services are planned to take a lot of experiments to the moon, but it's not yet mature enough to take New Frontiers-level missions.
- *Q - for small bodies missions going now in Discovery, how do you maintain programmatic balance?* Lori - comet sample return - comets are a gap, and there is still something we are not getting with current missions. Same for Io - it's a unique body.
- *Q - for Mars Sample return "shortfall" - the Decadal Survey recommended that NASA seek additional funding for this mission from Congress to avoid taking the funds out of other programs. Is this something PSD is planning to do?* Lori - Thanks the Decadal Survey for their recommendations regarding Mars Sample return. The Decadal survey wedge is not exactly what is needed for Mars sample return, so it's not a real shortfall in particular. They are working to give as much justification as possible to the appropriations process to get as much funding as possible. Congress has provided additional funding in the past (but that's not to say that will happen again).
- *Q - will there be a separate call for mmx participating scientists for sample analysis, like for Osiris-rex?* Lori - Yes. They are working with JAXA to have on-ramps for participating scientists - remote sensing first, then sample scientists. Stay tuned!
- *Q- Who makes the decision on which M2020 samples to return? Is this a rover mission decision or is it made by NASA?* Lori - right now they are collecting a diverse set of samples. They can collect ~47 tubes, and have engaged with the community and ESA to determine which samples will be deposited on the surface now (~11-12 samples). The sample return lander can hold up to 30. They

might not continue to collect paired samples. Which 30 samples will be returned is an important decision, and ESA and NASA will work to decide this.

- Q - *The Perseverance team has still not released a paper describing the contamination state of the sample return hardware. Can we expect a paper describing which contaminants are present and at what concentration?* Lori - does not have the answer to that right now.
- ExMAG - Please send this message (about contamination state) to Lori and Shoshanna, and they will try to get the answer to this.
- Q - *when do mmx samples come back?* Lori - 2030? She will double-check.

Any further questions - please let us know!

The ANSMET Program and Meteorite Nomenclature - Jon Friedrich

2.00pm: ANSMET collection highlights and importance, Cari Corrigan, Smithsonian Institution

- This is a big collection to talk about in 15 minutes!
- There was a lot of discussion in the Spring meeting, but I'll give an overview first.
- Program started in 1976, and was a joint program with Japan. After about 5 years, a formal arrangement between NASA, NSF and the Smithsonian was created. The Smithsonian does the long-term curation. ANSMET is the part that collects/recovers the meteorites.
- We're in about the third wave of people who have run the program. It was built by people who are no longer around.
- An overview - field teams of 6-8 people go to Antarctica for about 6 weeks, find meteorites, bring them home. Then meteorites stay frozen until they get to JSC, where they are thawed in nitrogen. JSC does the initial characterization, then sends a chip to the Smithsonian. Ordinary chondrites are examined in the SEM. If it's something unusual, it is classified by microprobe. There is an off-site storage facility in MD where the collection is then housed.
- Importance of the collections - they stay thawed initially to minimize contamination.
- All samples are classified (about 95% are classified at this time), allowing statistics to be determined. Kevin Richter works to determine if any samples are paired. There are 23000+ meteorites waiting to be studied by you! This is a cheap method of sample return ;) This collection has added to the number of planetary bodies sampled, increased the number of groups of meteorites, and is free and available for anybody to study.

- There are about 181 named meteorites that are protected because they are especially rare, or there are limited amounts left.
- In terms of sample requests, there are a lot of requests related to current missions. Right now, carbonaceous chondrites and iron meteorites are receiving a lot of requests.
- Collection overview - ordinary chondrites make up about 95% of chondrites. Most achondrites are HED's and irons. There are 755 achondrites compared to over 21000 chondrites. The collections have helped us to expand the number of planetary bodies that we have material from - the first lunar meteorite recognised (by comparison with Apollo samples) is from Antarctica. It was recognised as weird immediately, due to its greenish crust. Brian Mason recognised it as similar to the lunar rocks he had been studying, and Ursula Marvin too. There are lots of other fab lunar meteorites in the Antarctic collection.
- Aubrites are often confused with lunar rocks in the field.
- Martian meteorites - ALHA 77005 is the first recovered Martian meteorite, while ALH 84001 is probably the most famous. This is the Martian meteorite that they thought contained signs of life, although in the end it wasn't the case. It does have cool magnetites and carbonates though, which tells us there was once liquid water on Mars.
- Other Martian meteorites - the MIL 03346 nakhlites contain iddingsite veins that show alteration that took place on Mars.
- There about 250 HED's from Vesta.
- Helped establish new groups - e.g. lodranites, brachinites, as well as E chondrites, Carbonaceous chondrites. The CR's are probably the most requested right now as they range from pristine to altered. There are also pristine CO chondrites in the Antarctic collection.
- Look at the meteorites available, see how much is available, and put together a good justification to get material! There are many interesting meteorites available - some have even been misclassified.
- Check out the book "33 Seasons of US Antarctic Meteorites" for more information, and for more ideas on projects.
- Other countries have Antarctic meteorite collections too.
- Thanks to everyone involved - there are many more interesting samples that might be out there in the ice!

2.15pm: Issues facing the ANSMET program, Ralph Harvey, Case Western Reserve University

- Going to talk about "issues" around the ANSMET program and collecting in Antarctica.

- History of the ANSMET program - about 10 years ago, NSF defunded ANSMET. From 1976 until 2013, most funding came from the NSF US Office of Polar Programs. Part of this was that a lot of the meteorite research was not an NSF priority. Luckily, NASA picked up the shortfall (within 3 days) so that no field seasons were lost.
- Now, 3 seasons have been lost - this is a big deal. Funding is however good, as during the pandemic costs could be cut so that funding could be extended into next year (thanks to no-cost extensions).
- For future funding, a proposal has gone in and they are waiting to hear about this. Funding is not an issue as the project exists right now.
- Generational ANSMET - this will be the third generation of leadership. New proposal has Jim Karner as the PI, and Brian Rougeux as the lead mountaineer. This is creating a less perishable archive for the future. Volunteers still apply, the media is still interested, and they are working to increase interest among under-represented communities, so there is still a lot of interest in the program.
- Programmatic things - there are some clear issues. The ability to support deep field projects (e.g. airplanes, gasoline etc) is severely constrained. Pilots are no longer people who are training for the military, and the places you can go to are more restricted. McMurdo capacity has dramatically reduced - the pandemic hit just as they were planning a major rebuild, which was just the worst timing. Some things were not well planned, or the timing was not right. Smaller planes are being used. USAP oversight is becoming more cumbersome in regards to field safety, planning, and "behavioral management". They are exploring NGO or third party options, but these are likely to be expensive. There is not a lot ANSMET can do to change these, but ANSMET is trying to adapt to the changes.
- ANSMET was canceled this year - not because of the pandemic or logistics - but because it was not deemed "critical". NSF has a congressional mandate to manage all activities in Antarctica, and has prioritized activities based on their own criteria. So ANSMET needs to know how "critical" is defined.
- How to "fix" not being critical - ANSMET cannot change its remit, so can they change what "critical" means to NSF? This would need activism at VERY influential levels. Is there a mechanism that can engage with USAP management personnel? USAP have their own program managers to advocate for them for things like astrophysics and paleontology, but they do not have planetary materials program managers. Ralph does not have the answer for this. **Potential ExMAG action - Maybe ExMAG could - there is a 3-agency group called the Meteorite Steering Group, but they are more about managing Antarctic meteorite activities.**
- When the field season was cancelled, many people did complain to USAP.

- Some kind of action probably is needed. What this action is is not exactly clear right now, but needs discussion.
- We need to answer why we need more meteorites, why do we need them now? Why don't we work on what we have already? There are huge gaps in our knowledge - there are samples we should have but don't see in the collection. There is still so much to learn. Convincing people who don't do what we do is a big part of keeping the program going.

2.30pm: Lunar meteorite nomenclature update, Jon Friedrich, Fordham University

- Update on ExMAG Lunar subcommittee activities.
- One of the tasks is to help clarify Lunar meteorite nomenclature and simplify naming of lunar meteorites. Jess has been the lead on this, Francis is the chair of MetSoc NomCom committee, along with Katie Joy.
- Looking at the MetBull, there are 562 lunar meteorite entries, but one of the issues is how to subclassify them. There's "lunar" which is not descriptive, and other names which are maybe too specific (e.g. lunar norite).
- One of the goals of this group has been to create an easy-to-use and flexible system for naming lunar meteorites. This will make classifications more useful and informative, and make it easier to relate Apollo and Artemis samples to lunar meteorites.
- The group began thinking about nomenclature and sample return e.g. Mars/SNC samples; Vesta/HED samples etc. How do we deal with sample return nomenclature in the future?
- The slides include a flowchart for the necessary aspects of nomenclature. Different classifiers may not have the same expertise/access to equipment/time to classify samples etc.
- The scheme has to encompass existing samples, but also be flexible to accommodate new and unknown samples.
- Tier 1 of the flowchart has two initial categories: igneous and non-igneous. This goes on to list 6 final categories, that should be determinable by looking at the hand specimen, and the Fe/Mn ratio (can be determined by microprobe). Some submitters include O isotopes, but this should not be necessary. In principle, a classifier can submit this to NomCom.
- If the classifier wants to go into more detail, there is a second tier that will involve intensive SEM or microprobe work. This should not be necessary for classification (chemistry, chemical composition, potassium content, REE concentrations etc), but is more intensive if the classifier wishes to take these steps.

- There are other samples that we don't have examples of, but which might exist, and we may find someday, and the classification scheme also needs to work for these.
- Current MetBull classifications will not be retroactively changed (although Jeff notes in the chat that he would support this).
- Look for presentations and a MaPS paper next year.

2.45pm: ANSMET program and meteorite nomenclature Q&A

- *Q For Cari: Can you talk about the relative importance of the ANSMET meteorites vs the hot desert meteorites? Are there studies and information enabled by cold desert meteorites that can't be done (or can't be done as well) on hot desert meteorites? Assuming yes, is this part of the sell we need to do?*
Cari - yes, and this has been focused on in MWG meetings. The people who do organics appreciate that efforts are made to protect them from the elements, compared to hot desert meteorites. There are many African meteorites coming available, but they are generally more weathered. Antarctic meteorite weathering is well characterized. Many hot desert countries also have export restrictions.
- *Q For Ralph: Can you place the overall impact of ANSMET to the astromaterials community (various studies and papers supported) vs. an individual NSF deep field program (paleo, seismo, etc.)? Surely the annual meteorite studies from ANSMET meteorites far outstrips any other individual program.*
Ralph - They do, and they've done that in the past. They have made the case in the past that the only comparable program is the Apollo project. Kevin Righter might have the publication numbers (Ralph doesn't have them to hand), but it's fair to compare ANSMET to Apollo in terms of the impact. Kevin - at least ~2000 publications since 1977, and they don't keep track of abstracts.
- *Question for NASA: The decadal survey indicates that continuation of collecting Antarctic meteorites is a priority. How responsive might NSF be to the planetary decadal? Does NASA get asked to comment on how "critical" this program is?*
Jon - NASA doesn't get to comment on the definition of critical. Ralph - It's the NSF definition that needs to change, and NSF would argue their opinion "outweighs" that of NASA.
- *Q For Cari... Ralph talked about what support recovery efforts need but what about support needed at the Smithsonian to keep this important classification work going? Do you have what you need?*
Cari - On the positive side, the meteorite division has just had a new hire so there are now 2 official collections people (Julie and Kelsey) which will help. They also still have contractors and volunteers they can call on. As with everyone, they are constantly being asked to do more with less. NASA has been helpful in supporting Cari with the classification process.

- *Cari, have there been any field areas that have been particularly productive with respect to generating more popular samples? Are they worth prioritizing for future field seasons?* Cari - look at the last chapter of the afore-mentioned book. Ralph - yes, they would love to go back to areas where cool things have been found. In practice, there are a lot of factors that determine where they can go, not just there being cool samples. There are a lot of logistics. E.g. La Paz is amazing and still has meteorites to be recovered there, but it is very remote and hard to get there. They try to get as much done as possible, but sometimes even throwing money at the problem won't help - there are only so many planes, pilots, summer months etc available. Cari - statistics show that the more meteorites collected from an area, the more similar each place looks. The percentages of what are found in each area are important.
- Kevin notes that it may be worth trying to get the three agencies together again to talk. Jeff notes that the meteorite subcommittee is always welcome to invite whoever it wants to attend their meetings (NASA, NSF, whoever) so there's been no change since the MWG days except that you're driving. NASA and NSF do have high-level dialogue, and have the ability to comment on their priorities. There is a mechanism for that discussion. It is time to have that dialogue again. Ralph asked NSF who at NASA they had talked to about canceling the ANSMET season, and they said they had not talked to anyone prior to making the decision to cancel (although they may have talked to NASA after the decision was made).
- *For Cari: When looking at new samples from the latest field season, do you prioritize unusual looking samples etc.?* Cari - There is a trend in early seasons that the cool samples are 001 (e.g. ALH 84001), then in later seasons things are more mixed up. Cari takes the samples from JSC when they arrive, and they probably go through the notes and high-grade the cool-sounding ones. Kevin - Cari is correct. JSC picks out a subset of the samples that look interesting and uses that as a starting point. There are many samples that are totally fusion crusted, so they are discovered randomly (which can be fun too!). Cari - they look at every chip that is sent to them, and 100 EDS points are run on each chip (oil immersion is not done any more).

IDEA Initiatives in Planetary Science

3.15pm: Cross-AG IDEA group activities, Manavi Jadhav, University of Louisiana at Lafayette

- Purpose of the working group is to develop and disseminate IDEA-related resources, findings and recommendations. It is like an AG, but not an AG.

- The group currently has 110 members who represent different AGs. Email planetarydi@psi.edu to sign up or for more info.
- Cochairs - Maggie McAdam and Julie Rathbun
- They meet monthly.
- The IDEA group has developed 27 white papers for the Decadal Survey - the slide contains a link to the full list. The list covers things from mental health to best practices. Papers and conference presentations will follow.
- IDEACON took place earlier in 2022, and recordings are available online.
- The group is still working on developing best practices and standard procedures. Accessibility of AG meetings can be improved and standardized. In future they will work with societies representing under-represented communities.
- They are establishing best practices for conferences, including acknowledging indigenous lands, and encouraging participation in mental health surveys (see link in slide). Also see the IDEA website hosted on the LPI page.
- IDEA Working group recommendation for ExMAG:
 - Code of Conduct
 - Best practices for steering committee hiring - the model for this is VEXAG
 - Support IDEACON recommendations to PAC so we can present a united front with other AGs
- Future plans:
 - Looking forward to NASA response to the state of the profession chapter
 - Continue advocating for workforce demographics and climate surveys
 - Advocate for targeted action to support scientists who have been affected by the pandemic
 - Endorse recommendations from IDEACON
- Contact info - see slide for email address and website

3.30pm: Advancing IDEA workshop outbrief, Kennda Lynch & Edgard G. Rivera-Valentín, Lunar and Planetary Institute

- IDEACON Debrief
- This conference happened in April 2022 (April 25-29)
- The goal was to bring together the planetary, astrobiological and social science communities to facilitate the advancement of IDEA principles in the workforce over the next decade. This came shortly after the state of the profession chapters were published in decadal surveys. They wanted to focus on tangible steps that can be taken to improve IDEA principles.
- QR code is available on the slide, and there are links to the presentations.
- 70 abstracts received, 427 people registered, ~100 people online.

- The conference team was diverse, and there were 4 keynote speakers. Half came from social sciences, and half from the planetary/geosciences community.
- There were abstract-led talks, and also workshops and resources, and working group sessions. These were designed to help folks do things such as writing proposals, foster discussions, and produce white papers. These sessions were about people, so there were also listening sessions. There were 2 co-facilitators for each working group who helped refine the recommendations. There were Zoom breakout sessions.
- Each working group presented their recommendations on the final day.
- Working groups:
 - Funding agencies,
 - Universities,
 - Research groups,
 - Professional orgs,
 - Employers,
 - Safety and accessibility,
 - Public engagement.
- Effective partnerships involve developing activities with the community you are trying to engage. Effective communication is necessary in order to engage your audience effectively. Thinking about best practices for interacting with other people is vital - we are a community, and that involves people.
- People are volunteering their time to do this work, so employers and funding agencies need to recognise this and support it.
- Codes of conduct need to be implemented. A work culture that adopts these codes is needed.
- The community should develop a repository for IDEA best practices, list of opportunities and activities, and a platform that enables community collaboration. LPI has a website where they are starting to provide this material. Having more organization in the future will really help to further push this forward.
- Next IDEAcon will hopefully be within the next couple of years.

3.45pm: IDEA initiatives Q&A

- *Question for Manavi: you mentioned that ExMAG should support IDEAcon recommendations to the PAC, is there a way that individuals not on ExMAG can also support that effort?* Manavi - Yes, other AGs can be pushed to support this. You can also join the IDEA working group - it is open to everyone. Kenndra - sessions will also be held at different meetings, so promote your programs to support these recommendations. Some of these recommendations are not just

for NASA, they are for all institutions. Ed - link in chat

(<https://science.nasa.gov/researchers/nac/science-advisory-committees/pac>).

- *For Ed/Kennda: Were there things that you found worked well at IDEA Con in terms of the format and sessions that you hope to have at future IDEA Cons or things that you tried that didn't work out as intended and likely won't be continued?* Ed - one of the recommendations is that IDEA work isn't funded, so attending meetings can be a burden. Making it virtual made it as accessible as possible. Kenndra - it's great to give working groups more time in breakout sessions as there is so much to discuss.
- *Q for Manavi, thank you so much for championing IDEA in the sample science community. I saw too late that ExMAG offered early career travel awards for participation at this meeting. Can you talk a bit more about how that can be used and who qualifies?* Manavi - any early career person (within 10 years of your PhD, although career breaks don't count towards the 10 years) can request up to \$2000 for any reason that will help you to attend the meeting (child care, elder care, etc). Kate - this is the first time we offered this, and we are open to suggestions about how to advertise and institute this to make it more widely available.
- *For Manavi: I saw there is a mentoring program for ExMAG meetings. Can you tell us about it?* Manavi - for any first-time attendee, they can meet with a mentor who will explain what ExMAG is and what to expect from the meeting. Again this was our first time offering this.
- *Ed and Kennda: Are there lists/names of minoritized institutions and organizations that can be shared with the ExMAG community so that we can engage with them? Can the names be placed in a public repository of some kind?* Kenndra - there is a list available of minority-serving institutions (<https://msiexchange.nasa.gov/>) - they have to be defined by the government. Ed - the IDEA website (<https://msiexchange.nasa.gov/>) also has a list. Kenndra - this list will keep growing and get more organized over time.
- *Manavi, you mentioned a mental health survey led by David Trang. I haven't seen this yet, but was it put together with guidance from mental health professionals?* Manavi - yes, David Trang put this together, and it's part of his graduate project and is put together by mental health professionals. Please take the survey - deadline is in November.

Thursday, October 13th, All times Eastern

11am: Welcome, Barbara Cohen, NASA GSFC

- Welcome to Day 2 of the meeting. There will be Gathertown at the end of the day again, if anyone wants to join. Today we'll cover the Decadal Survey. Please think about what we want NASA to help us with, what we need to do to prepare for sample return, what technology we need etc. At the end of the day, we'll have a Findings and Discussion section - please send in any questions or comments.
- You are bound by the LPI Code of Conduct - please follow this. Do not screenshot or share info without the express permission of the speaker.
- Jemma - To join the Planetary IDEA, there is a post with info on how to do that from Kathleen in the Slido Q&A box.

The Decadal Survey - Jess Barnes

11.10am: The Decadal Survey: An overview, Bethany Ehlmann, California Institute of Technology

- Bethany will present an overview of the Decadal Survey. Her primary work is on the surface composition of planets. She will present the work on the Decadal Survey on behalf of the whole committee.
- You can download the Decadal Survey (all 800 pages) from the National Academies (<https://nap.nationalacademies.org/catalog/26522/origins-worlds-and-life-a-decadal-strategy-for-planetary-science>).
- The purpose of the Survey is to assess the status of an entire scientific discipline, identify key questions, prioritize initiatives and provide technical risk and cost evaluation (TRACE) for recommended projects and missions,
- The sponsoring agencies (NASA and NSF, plus Congress) use this document as a guideline for implementing science.
- This survey follows the same pattern as previous surveys. Key distinctions are a consideration of the state of the profession and actions for enhancing Inclusion, Diversity, Equality and Accessibility (IDEA). The report is organized by overarching scientific questions rather than by individual planetary bodies, and has a greater emphasis on astrobiology. It also includes Planetary Defense. Also the awareness of human exploration plans.
- There is a slide that shows the organization of the people who participated in the survey. Starting with chapter 22 is a good way to approach reading the survey.
- The leadership spans a range of scientific, technical and programmatic expertise. It also includes a social scientist, which was especially helpful for the State of the Profession section.
- >500 white papers were received, and 153 panel and 23 steering group meetings were run from fall 2020 to fall 2021. The slide lists several key milestones that

occurred during the compiling of the survey. The report was released in April 2022, and the NASA response was released in August 2022. Discussions are ongoing as we enter the 2023-2032 decade.

- In terms of question development, they now focus on science questions, not individual planetary bodies. The Decadal Survey questions line up with the questions submitted by the various AGs. The slide lists the 12 main science question topics and their scope.
- In the Science chapters, there's the high-level science priority questions, which are then broken down into sub-questions. Each chapter has specific research activities that are being suggested as a way to answer the questions posed.
- The overarching themes of the survey are:
 - How crucial sample return is
 - The dearth of knowledge of the ice giant systems
 - The importance of primordial processes
 - Various evolutionary paths of the terrestrial planets
 - Interplay of internal and external processes
 - Central question of how life emerged and evolved
 - Desire to make substantive progress this decade on understanding whether life existed (or exists) elsewhere in the solar system,
- State of the Profession (SoP): Mahzarin Banaji and Orlando Figueroa
 - Core principles include broad access and participation, understanding of how implicit biases affect judgment, and to implement objective measures of self-examination that will support IDEA and build community trust
- SoP findings include a significant amount of progress with respect to the role of women in planetary science, but there is a lot of work that still needs to be done to improve race and ethnicity recognition. Work-life balance issues are a leading factor negatively impacting the community. Implementation of dual blind peer review has helped reduce bias.
- Recommendations for SoP include: data gathering to know the current state of the profession; educating individuals about the cost of bias; broadening opportunities; creating an inclusive community free of hostility and harassment. Codes of Conduct should be implemented.
- Research and Analysis: advancing knowledge involves R&A - this is an essential component.
- Many white papers were submitted, and the Survey committee spent a lot of time analyzing these. The funding wedge has stayed flat, while there is still proposal pressure, and the selection rates are decreasing.
- So how to get a balance between getting data from missions, and being able to analyze that data. There is a minimum funding level of 10% of the budget that

should be devoted to R&A, and this should be revisited halfway through the Decadal.

- We need a consistent definition for R&A to avoid confusion. Some issues were called out with specific programs, and there is a need for greater understanding of the R&A programmatic portfolio.
- Infrastructural aspects: NASA and NSF both play a role in the planetary science enterprise. NASA and NSF should streamline mechanisms to support planetary science; develop ground-based radar, and to support the continuing telescopic observatories for planetary astronomy.
- Astrobiology- plays a central role in decadal research strategy.
- Mission recommendations:
 - Europa Clipper - continue, Clipper remains a priority
 - Mars Sample Return - lots of discussion, sample return is a high scientific priority (as it has been for over 25 years). Recommendation - this is a fundamentally strategic important endeavor, so highest priority is to complete sample return. Mars sample return is hard (and therefore expensive) - historically it has been ~25% of the PSD budget, right now it's about 20%. It is clear that if there is cost growth, this would undermine programmatic balance, therefore care has to be taken that the budget is augmented to avoid this.
- Mars sample return - sample receiving facility:
 - 3 stages: receiving and characterization, distribution, and long term curation
 - Biohazard requirements are challenging - need to start thinking about this as soon as possible
 - End-to-end plan for receiving facility needs early engagement of community, government stakeholders
- Mars Exploration program:
 - Success story going all the way back to the 90's!
 - Multiple missions coordinated, and international collaboration was key.
 - Recommend continued execution of this program
 - Next priority for medium-class mission should be Mars Life Explorer
 - NASA should consider ice mapping mission (relevance to human exploration, and climate science questions)
- Human exploration:
 - Aspirational and inspirational, hold promise of broad benefits
 - PSD should execute a strategic program to accomplish planetary science objectives for the Moon
 - SMD should have responsibility and authority for integrating Artemis with human exploration capabilities

- Lunar Discovery and Exploration Program:
 - Commercial Lunar payloads (CLPS). Decadal says this is promising, and should continue to develop a plan to maximize science return from CLPS.
- LDEP strategic mission: Endurance-A
 - Coordination with Artemis
 - Result would be flagship-level science at a fraction of the cost to PSD
 - Lunar programs highest priority
- Planetary Defense:
- Success of DART mission
 - Decadal recommends development of Near-Earth Object Survey
 - Next priority - rapid response mission
- Infrastructure:
 - Plutonium
 - Launch vehicles
 - Uplink/Downlink capabilities
 - Continued funding for curatorial facilities, continuing support for collection of astromaterials on earth, build partnerships with ESA and community
- Technology development:
 - Should be 6-8% of PSD budget
 - Create technology Program Plan
- Discovery Program:
 - Discovery plus programs like SIMPLEx
 - Has been a very successful program
 - Cost cap recommended at \$500 million
 - Committee strongly supports Discovery missions, however the large difference between cost cap and real costs makes budget planning complicated. Recommend simplification of this by having a single cost cap of \$800 million for the entire lifetime.
- SIMPLEx - very small cost cap
- New Frontiers - medium class mission
 - Should science be specified, or open to ideas from the community? Recommendation is that decadal should still continue to specify the themes, and be strategically directed.
 - Committee carefully deliberating cost cap - some missions (e.g. Dragonfly) have more than twice the cost cap, but the Survey supports this as it thinks the science return is justified.
 - So some missions will need an increased cost cap - \$1.65 billion allocated.
 - 13 missions considered, 8 prioritized. See slide for list.
 - Increasing importance of in-situ science and samples return

- Flagship missions: 6 considered, Ice giant mission judged to be top priority as we don't have as much knowledge of these, and it is complementary to other missions.
- Uranus Orbiter and Probe judged highest priority for a new mission, technically ready to start now. Optimal launch in 2031-2032 period. Strong international partnership opportunities for this.
- Second priority is Enceladus Orbilander - is Enceladus inhabited?
- Budget planning assumptions: Decadal went through various budget considerations - includes level program, plus budget that is 15% higher over the next decade. Recommended program includes all missions currently in operation and development.
- Recommended program profile - increased planetary budget would bring cadence of missions to recommended levels. A level (flat) budget pushes the start of some missions back a bit.
- Each recommended mission traces back to a science question. Some drill in to one or a couple of questions, others address a whole suite. The science and mission priorities really met in this Decadal.

12.20pm: Sample analysis in the Decadal Survey, Rhonda Stroud, Arizona State University

- Astrobiology called out explicitly in the decadal survey. There are 700 references to "sample" in the Decadal. This talk will focus on highlights from the Survey, as there is a lot to cover!
- A real effort was made to integrate different communities in this Decadal.
- Panels consisted of people with different specialities, then assigned to different questions of activities and science.
- The 12 science priorities are listed. The sample analysis laboratory study appears in each of these chapters.
- Chapter Q1: Evolution of the Protoplanetary Disk - what were the initial conditions, processes that built planetary building blocks, their nature and their evolution? Variation in physical conditions, timing and role of injection of supernova material. Uses samples returned from comets and terrestrially-collected IDPs, and lab isotopic analysis, plus telescopic observations.
- At the end of the chapter is a list of supportive activities:
 - More terrestrially - based sample collections;
 - expanded lab instrumentation development;
 - lab observations of samples returned from Ryugu, Bennu and Phobos;
 - telescopic observations.
- Chapter Q2: Accretion in the Outer Solar system: how did we go from pebbles to planets?

- Again, sample analysis is key.
 - Lab analysis meshed with theoretical studies of physical processes.
 - NC/CC dichotomy came up in several chapters
- Chapter Q3 - origin of earth and inner solar system bodies
 - Types of asteroids v samples in our collections
- Infrastructure Chapter:
 - Support and maintain infrastructure that enables collection of astromaterials on earth
 - Define sample temp requirements for curation and processing of samples
 - Joint NASA-NSF research proposals would strengthen science programs at both agencies
 - Decadal endorses prior studies conclusions, and recommends longer-term funding support for technical staff is desirable
- Recommended (aspirational) budget shown. What would we do if we had a real increase in funding? We likely won't get this budget, but we should argue for it.
- Even in the level-funded budget, there will be tradeoffs that limit what we can do in the timeline we want. Mars sample return is a high priority - there are a lot of samples we want to bring back, but we need to recognise it cannot eat the whole planetary science budget. If costs increase beyond ~35% of the PSD budget, NASA should work with the Administration and Congress to augment the budget.
- We also have to be prepared to handle the samples when they come back. Some of the work to build the receiving facility is underway already.
- New Frontiers: next level of mission below Flagship. NF should continue to specify mission themes as determined by the Decadal Survey.
- The Decadal committee didn't change the priorities from the prior decadal:
 - Comet surface sample return
 - Lunar South Pole-Aitken Basin sample return
- NF should evolve over the next decade - Phase E cost should be included in the cost cap, to enable access to all targets in the solar system.
- For NF6, two sample return missions included in recommendation:
 - Ceres samples return - most ice-rich body in the inner solar system, samples to include young carbonate samples and dark materials. Helps us understand habitability of dwarf planets
 - Comet surface sample return - map comet nucleus and return sample to earth, helps constrain the role of cometary delivery of organics and water to early earth
- Human exploration: The advancement of high priority lunar science objectives should be a key requirement of the Artemis human exploration program
- Commercial Lunar Payload Service (CLPS) - robotic program. Fast, flexible, reliable and affordable access to the lunar surface. If human integration can be

integrated with robotic sample return, then that would give us the best of both worlds. Easier to bring back volatiles and ices with humans is much easier than by robotic return.

- Technology development is something we really need to pay attention to. Are we developing the tools we need? What are the technology gaps?

12.30pm Decadal Survey Q&A

Q - Has there been discussion of the disconnect between workforce demographics studies showing that Black women leave planetary because they don't get jobs, while efforts to improve the representation of Black women in science focuses on getting middle school and high school girls interested in science? Bethany - broad comment on the Status of the Profession chapter contains discussion of whether it is a stream or pipeline that leads to where we are. All levels need mentorship. There are a lot of studies about the impact of this on people with different backgrounds. There are a number of steps that all need to be considered. Key recommendations: restore some of the pre- and post-doctoral programs for under-represented communities. Rhonda also notes that the need and success of the workshops on getting involved in missions and PIs had been successful, and should continue.

Q for Bethany: Did previous Decadal also recommend an increase in R&A spending? If so, what does the fact that NASA didn't do so portend for the future? Bethany: sociology of how we do recommendations matters. Some topics are lumped together. Some recommendations have been funded, others have not. Recommendation for merging programs happened, but the one to lengthen awards did not. Continue to look at the chapter and push on some of the recommendations.

Q - Bethany or Rhonda: SPA return is included in NF5 mission list - if this were selected, would NASA be expected to go forward with Endurance A? Or conversely does DS rec for Endurance-A decrease likelihood of SPA sample return in NF5?

Rhonda - the Decadal has no control over what the selecting officials will do with regard to the recommendations. This is community driven - people can make the case. Budgetary considerations will reign in the end.

Q for Rhonda: Sample Return missions are currently required to include curation facilities and activities in the mission cost. Can you talk about the potential trades the decadal survey discussed about how that could negatively affect sample-return missions with cost caps? Rhonda - They didn't get down into the details specifically of cost caps. They looked at how long the curation for the samples needed to be included in the mission, as it's essential for the success of the mission that there are suitable facilities available. They tried to make it as widely possible to sample return in a realistic

way as it is critical to the success of a mission. Bethany agrees and adds that in setting the numbers and recommendations, the intent was to preserve that sample return and be able to compete robustly within the cost cap. What needs to be under the cost cap of the proposers versus NASA's long-term curatorial commitments. The NF draft is open for public comment - please note the date may be October 31st (but this needs to be checked) - ExMAG folks can submit comments to NASA. Rhonda - the Decadal makes recommendations, but is not set in stone! People can still comment on this.

Action - ExMAG response to the New Frontiers Draft.

Q for Bethany: Are the plans for where the SRF for MSR will be built? Will it be built at NASA JSC? Bethany: The Decadal is agnostic - there was no recommendation on the location of the facility. There are JSC people who are involved in the planning, but a decision has not been made yet.

Q for Rhonda: With respect to funding for instrumentation and laboratory staff, were there specific \$ amounts/yr recommended by the decadal and are those projected to be met through PSEF/other R&A programs? Rhonda - there are not specific dollar amounts recommended. It's in the R&A program, but that was too prescriptive to give specific dollar amounts for lab instrumentation.

Q for Bethany: Does I-MIM address "priority climate science questions at Mars related to near-surface ice", or does it just focus on ice mapping? I haven't heard of any instruments other than GPR. Bethany - This was a concept that is an international partnership with Canada, Italy and Japan, and NASA. The science definition team was convened and was in the process of defining the goals, although it is now no longer in NASA's portfolio. The mapping of ground ice will enable the upper meter of ice to be mapped. So the mapping of ground ice by the currently envisioned Canadian contributed radar system will enable that upper meter of ice mapping is relevant to in situ resource utilization and also relevant to climate prediction. Ice mapping was recommended by the Decadal, but has not kind of disappeared - this is an ongoing discussion in MePAG.

From the Chat (James Tuttle Keane): Rhonda mentioned that Endurance-A is a much "bigger" mission than the traditional New Frontiers SPA-SR. Endurance-A was designed to be the same cost as a New Frontiers mission. (\$1.5B total cost, within the Decadal's guidelines for New Frontiers cost). It's not necessarily a bigger mission than SPA-SR in terms of cost. (We can talk more about Endurance later, too). James will talk about this in the next session.

Q for Bethany: Did the decadal discuss evaluating effects of climate change (on Earth), particularly regarding where samples are stored and curated? Bethany - in terms of the

curation of the samples so that they preserve their planetary properties is critically important. Ice, hydrated minerals, require specific facilities to curate and characterize them, as things may change in the Earth environment. Beyond that, the Decadal does not specifically comment on samples being modified in the earth environment. Jess - should we discuss how climate change on Earth will affect where samples are stored and curated . Bethany - the Decadal did not comment on that aspect.

From the Chat (James Tuttle Keane): We did not book-keep the cost of Artemis missions (which are very large). Bethany - if we as a nation are going to the moon, let us make sure that the science that the astronauts do is extraordinary and so Endurance basically is a way to do a different flavor of South Pole Aitken basin sample science.

Upcoming Sample Return Mission Concepts - Rhonda Stroud

1:20pm: Artemis planning update, Sarah Noble, NASA HQ

- Lots of upcoming calls: ANGSA2, SSERVI CAN 4, PRISM 3, Analog activities/ DALI/ LDAP. Coming out soon - Artemis 3 Geology team, and others still in development.
- 50 years since there were humans on the moon - Artemis 1 launching soon. Potential landing regions for Artemis II announced, and a workshop is in planning for early next year.
- Internal Science Team Assembled - Training and ops, Samples, Planning and Data, and Payloads. They are in the process of adding to the team. Also hiring for an Artemis Curation lead - that call should come out from JSC within the next month or two.
- Analog activities in progress
- Community input requested for what can be done at different landing sites - see upcoming workshop
- Role of Internal team v Competed Geology Team (call for the latter should be going out soon). See slides for roles and responsibilities of both teams. Competed Team is focused on Artemis III.
- Analog Activities are in the works - they got to simulate a complete mission from start to finish, and many lessons were learned. Another call will go out to do this again next year, open to US-persons.
- The science evaluation room shows the team figuring out the best way to traverse the landscape. This was useful in figuring out roles and communication.
- Artemis training consists of several phases - they worked hard over the last decade to incorporate more geology training into the astronaut training. Astronaut crews have gone out as field assistants to learn how to do field work. The real training will start when the crew is assigned (probably about 24 months out).

1:30pm: Mars Sample Return update, Meenakshi Wadhwa, Arizona State University

- Update on MSR
- The architecture for MSR was finalized relatively late (towards the end of Phase A), and they are just starting out on Phase B.
- The campaign is made up of several different parts - Perseverance is collecting samples in Jezero crater. There are 2 launches coming up - 2027 (Earth return Orbiter, ESA leading this), and 2028 (Sample retrieval lander). The latter mission will also have 2 helicopters in case Perseverance has any issues. Sample return in 2033, and then there will be the Sample Retrieving Project.
- Perseverance is currently in the delta front. There are 14 core samples retrieved so far, 8 from the crater floor, and 6 from the delta front. There is also an atmospheric sample that was collected.
- There are also 2 witness samples, and a third one is in the process of being obtained.
- The slide shows some of the samples that were collected, and their locations. There is a diversity of samples that have already been cached.
 - First successful rock core from Rochette outcrop, each about 6cm long, made up of plag/pyroxene basalt.
 - Next sample collected from Brac outcrop is an olivine cumulate with a lot of carbonate in it.
 - Next is from Issole Outcrop, a cumulate igneous rock with secondary carbonates.
 - Next is Sid outcrop, pyx-plag basaltic rock
 - Skinner Ridge outcrop - sedimentary materials from Hogwallow Flats region of the delta front (as opposed all the igneous rocks from inside the crater).
 - Wildcat Ridge - fine-grained sedimentary rock, organic rich, sulfate veins, strong fluorescence.
 - Amalik outcrop - fine-grained sedimentary rock, weak fluorescence. This sample is in the process of being sealed.
- All MSR science objectives could be addressed by the samples cached so far. Igneous, sedimentary rocks, aqueous alteration products, organic compounds. Samples will address major gaps in our knowledge of concern to future human exploration.
- Planning underway to establish the first depot. Workshop held in late September to discuss this. See slide for summary of workshop findings.

1:40pm: Ceres: Exploration of Ceres' habitability, Kelly Miller, Southwest Research Institute

- Kelly is one of the geochemistry experts on this mission.
- After the Dawn mission, Ceres is still of high interest. Dawn uncovered compositional similarities with carbonaceous chondrites - it is a water-rich body (~40% water) plus evidence for abundant organics. Ceres is geologically active within 2-200Ma, and contains ammoniated compounds (maybe ammonia ices, or associated with complex organic materials?).
- Key questions for this compelling asteroid:
 - Why is Ceres active, are deep brines habitable, where did Ceres come from?
- 6 science objectives:
 - Did extrusion form a brine-rich mantle,
 - endogenic activity,
 - depth of liquid water,
 - deep brine environment,
 - Evolution of organics,
 - accretional environment
- Ceres sample return - brine samples considered as best chance of answering questions.
- Mission has an orbital phase (500 days) for mapping and reconnaissance to get an idea of geological activity. Then the mission will land (~3 weeks), perform experiments to look at brine activity, then return to earth (4.7 year cruise). Sample capsule will be kept at low temp to minimize reactions in the sample.
- NF mission - primary motivations for sample return:
 - challenges of organic detection in brine samples,
 - high precision measurements needed,
 - low gravity and proximity of Ceres are enabling,
 - returned material provides samples that can be studied for decades.
- Measurement priorities will be accomplished using a variety of techniques including FTIR, XRD, INAA, ICPMS, EPMA, FIB, Raman, NanoSIMS, EA-GCMS, GC_IRMS, TEM, SIMS.
- PlanetVac and Xodiac - compressed gas used to lift up surface material. Ammonia cooling system used on sample return capsule.
- Ceres can tell us about evolved carbonaceous asteroids, ocean world interiors, and the outer solar system.

1:50pm: Endurance: South Pole–Aitken Basin sample return, James Keane, NASA Jet Propulsion Lab; Sonia Tikoo, Stanford University; Brett Denevi, Johns Hopkins Applied Physics Lab

- Endurance concept - strategic medium class (NF-ish) concept
- South Pole-Aitken (SPA) basin - largest and oldest impact crater on the Moon. Huge - over 2000km in size, on the far side of the moon.
- Sample return has been highly prioritized in the last 3 Decadal surveys.
- SPA can tell us about solar system chronology - was there a late heavy bombardment? It can also provide a view into the interior structure of a rocky world. Giant impacts are prevalent across the solar system, but are poorly understood.
- 5 science objectives from Endurance. SPA is massive though. To get at the age of the surface, you might want to go to the impact melts. If you want to date impact melts, you want to focus on the impact craters. For mantle material, you want Th anomalies. For chemical info, you might want the recent volcanic activities. How to get samples from all of these places?
- Answer - do a long-range traverse across the basin.
- Potential materials: rocklets and regolith fines. Good for a whole variety of analyses.
- More = better. More samples from more locations, a lot of types of material from a variety of locations that can answer a range of questions. If NASA curation holds onto a lot of the material returned, that will limit the amount of science that can be done. The solution is to bring back as much material as possible.
- Endurance-A is a rover capable of sample collection, in addition to tools that can perform sample characterization. There are 12 canisters that could bring back up to 100kg of material. Astronauts will meet the rover, and decide which samples will come back.
- The instruments on the rover are flexible and could be redesigned if needed.
- The scoop can also filter samples to get a mix of rocks and fines.

2:00pm: Comet sample return, Rhonda Stroud, Arizona State University

- Comets are the best accessible archive of early solar system materials, preserving gas, dust and organic molecules from the proto-solar molecular cloud.
- There are some cometary materials available now - most of which is probably cometary but not necessarily tied to a particular comet. We do have Stardust materials, but most samples come from the stratosphere or Antarctica. Why do we need more?
- We don't have some of the most important samples that will help us answer our science questions. If we can get sub-surface samples without atmospheric

exposure (that IDPs experience) or damage/contamination from the sample-capture medium (like Stardust), then we can get more unbiased samples that are representative of a known comet.

- Cometary sample return has consistently been a high priority among the planetary science community
- How low in temperature can be sampled? Lower temp materials have better preservation of volatiles, and will show a wider range of cometary and early solar system signatures.
- CROCODILE: Cryogenic Return of Cometary Organics, Dust and Ice for Laboratory Exploration
- Relevant temperatures? Material in top 20cm reach 160-230K temps during orbital cycle. Too expensive to do a NF mission to get cryogenic samples, but non-cryogenic comet samples return remains a high priority. Cryo return will await developments in technology.

2.10pm Upcoming Sample Return Mission Concepts Q&A

Q - For Sarah: What is the current plan for sample return on Artemis? NASA has previously said it is limited to less than 100 kg. Can that number be increased to accommodate more samples? Sarah - It's still currently at 100kg, and they are still negotiating on ways to improve on this. Maybe samples could be shipped separately, and not come back with the astronauts. It's still a work in progress though.

Q - All speakers: what technological development support do you need (if any) to make these mission concepts achievable? Rhonda - there is a tech forum coming up, so it will be important for the community to be involved in answering this. James - would add that the Decadal Survey has a technology chapter too. For Endurance, the biggest thing is autonomy - it has to be able to drive faster on its own than previous rovers. (Fast still means ~1km/hour - faster than MSL, but not kicking up dust!). Kelly - for Ceres, the biggest thing needed would be the redeployable solar arrays. These are used during the orbital phase, retracted for landing, then redeployed again. The ISS has developed some of this technology, but it still needs to mature. Sarah - cryotechnologies, sample return etc - a lot of the sample return missions will face the same issues.

Q - For Kelly, can you comment on the preservation and recovery (as well as prevention of reactions with organics, etc.) of volatiles like NH₃ and CH₃OH that have freezing points well below the -20°C sample capsule requirement? Kelly - Samples return capsule used in the concept study would not prevent back-reaction of volatile gases, so ways to prevent additional alteration will need to be looked at. Ammonia and Methanol should not be present and volatilized anyway since they are not stable at Ceres' surface.

Q - Question for Mini: What NASA center is leading the SRP part of Mars Sample Return? Mini - at the moment JSC and JPL are working together on this.

Q For Rhonda - : How would a surface sample be compromised by space weathering compared to an interior sample which makes up most of our natural collection (vented particles for STARDUST/Wild 2; breakup of comets for IDPs)? Rhonda - we know from Rosetta, the surfaces of comets are quite dramatic. Solar wind implantation, volatilization, redeposition - but each comet is different.

Q for Mini: the ESA Fetch rover was an important part of the MSR architecture. Since that is no longer moving forward, NASA has to assume additional costs for providing the helicopters. How does that factor into the total mission cost being planned by NASA? Mini - can't speak to mission costs at the moment. In the meantime, the Fetch rover was going to need a second lander, so the architecture had to be changed. The revised architecture is not as costly.

Q for Sarah: Will there be a chance for the community to comment on the Artemis III geology team solicitation? If so, can you comment on the timeline for providing input? Sarah - planning to put out a draft when it is ready, and it will be left open to the community for at least a couple of weeks for feedback.

Q for Sarah: Will the data from these early training exercises (like last week's) be archived and made publicly available? Sarah - to some degree, yes, Part of the call is to make sure that communication is going back to the community. It just finished yesterday though, and there is a list of papers that will go out to the community.

Q for Mini: Did the 14th core tube finally get sealed? Mini - not just yet, but they're hopeful it will be over the weekend. No comments on what the problem is at this time.

Q For Sarah: Could an early Artemis mission deliver the Endurance-A rover? Sarah - it would double the traverse distance, so may be counterproductive.

Q for Sarah: Are there any card-carrying planetary scientists and/or geologists within the current ranks of the astronaut corps? Yes - Jessica Watkins, and there are a number of others with some geology in their background. After training, they all have the equivalent of a Masters degree in Geology anyway.

Q for Rhonda: Are labile organics present in UCAMMS (presumed to be cometary). Rhonda - The UCAMMS are recovered from the Antarctic snow, and the labile organics

can move around even in the snow. They might be present, but they will be difficult to study as the samples are so small. They are great for some studies, but not for everything.

Q - Could the panelists comment on what ExMAG could do for them and the community to help make these mission concepts happen? Rhonda - how do we help ensure that sample return is really viable in the NF-5 and NF6 calls? Participate in your AGs, in your community, things like that. Sample return really will be critical to answer science questions moving forward.

From the chat: Barbara - I think advocating for sample analysis funding really highlights the science that we can do with newly returned samples! James comments that he agrees with this. There will be challenges, but it's important for the sample science community to push for this, and for ExMAG to continue to advocate for this too.

Rhonda - this is always a relay race. Mars sample return is as close as it's ever been - maybe 10-15 years out. Mini notes that this is the resurgence of the golden age of sample return. The Decadal recommended and prioritized some sample return missions, so we need to advocate for this at every opportunity. We need to come together and have a united front.

Q - Rhonda: What comet was targeted for CROCODILE? Rhonda - it's in the Appendix of the Decadal. They looked at a couple of different comets, but these would change if the mission went ahead. They looked at a typical cruise length to get an idea of the cost. Generically, something like a Jupiter-family comet. They tried not to be biased to any one comet.

Data Archiving in the Age of SPD-41

2.40pm: ExMAG response to SPD-41, Pierre Haenecour, University of Arizona

- SPD-41 was released last year. From the Data Ecosystem Review Board that there was a series of findings about data.
- The slide shows one key finding - there was no overarching data archiving method for different facilities
- One of the key things is the complexity of data collected during laboratory analysis. Curation - preliminary examination - creates a lot of data, as does the full analysis of samples using a suite of techniques. There are many instruments used, using different data products that produce a complex suite of results. How do we archive this, preserve it, and make it accessible in a useful way?

- NASA came up with SPD-41 - a consolidation of existing US Government policies and laws applicable to SMD scientific information. Publications, Data, metadata, software wtc. SMD-funded data should follow the FAIR principles.
- Findable, accessible, interoperable and reusable (FAIR)
- The policy was divided into 4 sections, plus Appendices. Appendix D shows guidelines for what makes an acceptable repository.
- SPD-41a should include info and guidelines on the plan, timeline and funding for the policy information. Should also provide clear direction for NASA-compliant repositories, and that spacecraft missions involving sample analysis should also follow these guidelines. Data should be released and archived within 6 months of being acquired, but this can create a lot of extra pressure.
- Suggestions for policy implementation - the use of internationally recognized persistent identifiers (e.g. DOIs, IGSN, ORCIDs and RORs)
- Another suggestion - community agreed-upon archival standards in a non-proprietary format.
- More suggestions - work with instrument manufacturers to ensure non-proprietary data formats, support of NASA-compliant repositories, peer-review process for metadata dictionaries, provide training.

2.50pm: AstroMat - Astromaterials data system overview, Kerstin Lehnert, Columbia University

- AstroMat - Digital data archive for lab data generated on extraterrestrial samples curated in NASAs astromaterials collections. Started in 2018 to provide an infrastructure for researchers to publish and archive their data. Should preserve data in a manner where it's not just catalogued, but provides analysis-ready data.
- AstroMat Data Services - Submission, Curation, Publication and Integration
- Data sets can be compilations, or new data sets. Some is data that was generated but not published, but needed a way to be available for the community.
- Can be accessed by APIs in the future
- What's new? New policies present new demands for lab-based data.
- AstroMat fulfils requirements for FAIR data. Publicly available, machine-readable, Accessible in convenient formats, can be retrieved, indexed, downloaded, and searched. Citable, robust standards-compliant metadata that clearly and explicitly describes the data.
- There are currently about 110 datasets (although more have just been added) - hopefully with the implementation of the policies, the content of the repository will grow. The UCLA Cosmochemistry Database has delivered a lot of data sets for this.
- Data Restoration for ARES Lunat and Meteorite collections completed.

- Migration of MetBase is almost complete.
- Astromaterials Data Archiving - started in March 2022 to address challenges for archiving astromaterials sample data. Need to archive ORex data, and data from future missions. A study was conducted to make sure the needs could be met.
- Special Study objectives - requirements were gathered for AstroMat to operate a data Archive that can fulfill NASAs needs, international standards, and the ORex mission needs. Existing components were explored, and recommendations for feasible options were given to NASA.
- The report takes a comprehensive approach to dealing with the needs of the community. Sample acquisition, creation, curation all have to be linked to the generated data.
- The slide presents the proposed structure, with AstroMat building up its archives from 3 different sources. They want to build a network of information as far as possible.
- Implementation plan sent to NASA with a way to move forward. Phase 1 & 2 (12 month period starting Fall 2022) to establish needs and capacity for archiving ORex ample data.
- Phase 3 - longer term plan to figure out needs and capacity for future missions.
- Focus on users - for the long term breation of the archive, they will focus on the users and on promoting open science engagement across the community.
- They encourage questions and comments on how to engage the community. They envision setting up an advisory board.

3.00pm: The NASA Planetary Data Ecosystem: A brief overview, Moses Milazzo, NASA

- Overview of the Planetary Data Ecosystem review board. Formed in late 2019 and reported in April 2021. Top recommendation - NASA needs a community-led group to keep in touch with the whole data ecosystem. Nasa decided to make a 1-person committee instead. Moses started work in Spring 2022 as an independent contractor not a NASA employee.
- Slide shows the Planetary Data Ecosystem as it is today.
- The PDE is a massive group of scientists, educators, artists, etc - basically anyone who interacts with the data.
- IRB developed a set of core values:
 - Do no harm
 - Be FAIR
 - Be open
 - Be collaborative
 - Be effective

- Be practical - the search for perfection can lead to no solution, rather than a solution that is good enough
- The slide shows a link to the report - there are 67 findings and 65 recommendations that were organized into 5 themes.
<https://science.nasa.gov/files/science-pink/s3fs-public/atoms/files/PDE%20IRB%20Final%20Report.pdf>
- Highest priority recommendations:
 - Develop the ecosystem - it's a good idea and should be formalized. The PDS is not the PDE and vice versa. NASA needs to participate in established communities, and learn from other communities.
 - Address data preservation needs - this is an ongoing effort. The collapse of Aricebo led to concerns about how the radar data would be preserved and archived.
 - Address barriers to use and development - actively seeking and acquiring input from ecosystem elements, provide training and outreach.
 - ExMAG action - ways to find funding for training and outreach, how to use software, etc
- The PDE is meant to acknowledge the wide diversity of people, data, data types, ways to store and preserve data etc.

3.20pm Data Archiving Q&A

Q for Moses: why did the review board include essentially no sample scientists? What does this mean for the recommendations? Moses - the review board was created by putting out a call to the community, and there were several subgroups. People volunteered to be on the board, so the only source of members was from people who submitted their CVs, and the chairs were just people who were willing. The percent of applicants who are sample scientists is unknown. Kerstin was directly invited, but other parts of the board were run by other people. Maybe sample scientists just didn't volunteer?

Q For Pierre, Kirsten - describe the boundary between hardware data vs proprietary data from spacecraft that is required to be archived for public access? I am thinking of how these materials affect sample analysis. Perhaps this information is excluded? Kerstin - this is part of the special study that these data need to be preserved, and are linked to other relevant data. This info should be preserved but is not in the current implementation plan. It's not clear how much of this info is currently preserved, or how much needs to be digitized. Moses - would also like to add: The IRB report is not the end of the PDE. It's the beginning. So, I'm here today and am happy to meet with

anyone to chat about all things sample. (Or rather, it's the beginning of NASA's more formal interaction with the PDE--the PDE existed already, of course).

Q for Kerstin: Are images (optical, SEM, etc) of astromaterials archived on Astromat, and For Kerstin: is this database going to be restricted to NASA funded projects?

Kerstin - They do already have some Chang'E data in the archive - some journals have policies requiring open access so those researchers are sent to AstroMat to archive the data.

Comment for Kerstin: At GSA this week there was discussion about the need for a database for Earth scientists' samples, and AstroMat sounds like an incredible example of what they want to do. Have you talked to Earth geologists/GSA about AstroMat?

Obviously theirs will be on a different scale. Kerstin - this started in the terrestrial world with e.g. volcanic data. We might need to discuss how much we want to link up terrestrial and extraterrestrial materials. There are also experimental petrology data in the database.