<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
<th>Expertise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sushil Atreya</td>
<td>Univ. of Michigan</td>
<td>Interior-surface-atmosphere interaction</td>
</tr>
<tr>
<td>Patricia Beauchamp</td>
<td>JPL-Caltech</td>
<td>Technology, Instrumentation, Chemistry</td>
</tr>
<tr>
<td>Penelope Boston</td>
<td>Ames Research Center</td>
<td>Astrobiology</td>
</tr>
<tr>
<td>Mark Bullock</td>
<td>Science &amp; Technology Corp</td>
<td>Chemistry of Atmospheres and Surfaces</td>
</tr>
<tr>
<td>Shannon Curry</td>
<td>U.C. Berkeley</td>
<td>Solar wind interactions with Venus</td>
</tr>
<tr>
<td>Martha Gilmore</td>
<td>Wesleyan. University</td>
<td>Surface processes, spectroscopy</td>
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<tr>
<td>Robbie Herrick</td>
<td>Univ. of Alaska</td>
<td>Geology and Geophysics</td>
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<tr>
<td>Jennifer Jackson</td>
<td>Caltech</td>
<td>Mineral Physics</td>
</tr>
<tr>
<td>Stephen Kane</td>
<td>U.C. Riverside</td>
<td>Exoplanet Science</td>
</tr>
<tr>
<td>Alison Santos</td>
<td>GRC</td>
<td>Petrology</td>
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<tr>
<td>David Stevenson</td>
<td>Caltech</td>
<td>Geophysics</td>
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<tr>
<td>Colin Wilson</td>
<td>Oxford University</td>
<td>Atmospheric Physics</td>
</tr>
<tr>
<td>Janet Luhmann</td>
<td>UC Berkeley</td>
<td>Venus escape processes</td>
</tr>
<tr>
<td>Robert Lillis</td>
<td>UC Berkeley</td>
<td>Modeling of plasma and magnetic processes</td>
</tr>
<tr>
<td>Joshua Knicely (student)</td>
<td>Univ. of Alaska</td>
<td>Venusian Volcanoes</td>
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</table>
SCHEDULE AND REPORT

Nov/Dec 2019 - Input from community, refinement of STM
Early 2020 – Engineering Run I
March 2020 - Interim Report at LPSC
April 2020 – Engineering Run II
June 2020 – Final Report Due
Marty’s 2018 VEXAG Rant:
Overview/ Punchlines – we need a plan

• Status of Venus in last decadal –
  • assumed Disco was perfect for Venus
    • *Need to show everyone (NASA/public) that Venus is important*
  • NF carryover from previous decadal (along with SPA)
    • *Should we push (somehow) the idea to redefine the NF call?*
  • Last of the 5 flagships
    • *Can we promote the flagship to the top of the decadal?*

What do we want to do, should be do, can we do?

• Community white papers – flood the panel!
• Publish paper in a journal ala the ocean worlds roadmap
• Publish paper in EOS or other journal with greater reach
2013 Decadal White Papers n = 199

1. **Ariel D. Anbar**, Astrobiology Research Priorities for Mercury, Venus and the Moon
3. **Kevin H. Baines**, Venus Atmospheric Explorer New Frontiers Concept
4. **Tibor Balint**, Technologies for Future Venus Exploration
5. **Mark A. Bullock**, The Venus Science and Technology Definition Team Flagship Mission Study
6. **Larry W. Esposito**, Mission Concept: Venus in Situ Explorer (VISE)
7. **James B. Garvin**, Venus: Constraining Crustal Evolution from Orbit via High-Resolution Geophysical and Geological Reconnaissance
8. **Sue Smrekar**, Venus Exploration Goals, Objectives, Investigations, and Priorities
9. **Allan H. Treiman**, Venus Geochemistry: Progress, Prospects, and Future Missions

Who will write the white papers? Also solicit contributions from Astrobio and Exobio – set a schedule.
VENUS FLAGSHIP
A MISSION TO ASSESS THE HABITABILITY OF VENUS
GOALS

1. History of volatiles and liquid water on Venus and determine if Venus was habitable.

2. Composition and climatological history of the surface of Venus and the present-day couplings between the surface and atmosphere.

3. The geologic history of Venus and whether Venus is active today.
Launch ~2029-2032

1 Orbiter
2 Orbiting SmallSats
2 Short-lived landers/Probes
1 Balloon
1 Long-lived lander (LLISSE)

Carry ESPA ring

Cost $2B
GOAL 1. UNDERSTAND THE HISTORY OF VOLATILES ON VENUS AND DETERMINE IF VENUS WAS HABITABLE.

Objective 1.1: Did Venus once have liquid water at the surface?

- **Investigation 1.1.A** - Measure the mineralogy and chemistry of the t Tesserae
  NIR on Orbiter/Descent | Mineralogy/Chem on Tessera Lander

  SAR on Orbiter | Imaging on Descent and Lander

- **Investigation 1.1.C** - Measure the atmospheric D/H in a number of gas species below the cloud deck to the surface.
  Mass Spec on Descent and Balloon
GOAL 1. UNDERSTAND THE HISTORY OF VOLATILES ON VENUS AND DETERMINE IF VENUS WAS HABITABLE.

- **Investigation 1.1.D** - Determine isotopic ratios and abundances of D/H, noble gases, oxygen, nitrogen, and other elements in the atmosphere of Venus.
  
  Mass Spec/TLS on Descent and Balloon

- **Investigation 1.1.E** - Determine atmospheric escape rates over a full solar cycle.
  
  Ion analyzer, magnetometer on multiple SmallSats

- **Investigation 1.1.F** - Search for evidence of a past magnetic field.
  
  Magnetometer on Balloon and Lander
GOAL 1. UNDERSTAND THE HISTORY OF VOLATILES ON VENUS AND DETERMINE IF VENUS WAS HABITABLE.

Objective 1.2: Where Is Venus’ Water Today?

- **Investigation 1.2.A** - Measure the volatile content, chemistry, mineralogy, and oxidation state of less weathered basalt.
  
  Mineralogy/Chem on plains Lander

- **Investigation 1.2.B** - Measure the composition and distribution of volatiles in the atmosphere.
  
  Mass Spec/TLS on descent and balloon

- **Investigation 1.2.C** - Characterize transport mechanisms from the solid surface to the upper atmosphere.
  
  Balloon tracking | Wind sensor on LLISSE
GOAL 2. UNDERSTAND THE COMPOSITION AND CLIMATOLOGICAL HISTORY OF THE SURFACE OF VENUS AND THE PRESENT-DAY COUPLINGS BETWEEN THE SURFACE AND ATMOSPHERE.

Objective 2.1: What is the composition of the surface and what are the implications for past and present climate?

- **Investigation 2.1.A** - Measure global mineralogy to distinguish major rock types and place in geologic context.
  
  NIR on Orbiter/Descent | Mineralogy/Chem on Tessera Lander

- **Investigation 2.1.B** - Determine the oxidation state, chemistry and mineralogy of primary and secondary minerals in basaltic rock and tessera terrain.
  
  NIR on Orbiter/Descent | Mineralogy/Chem on landers | Chemical sensors on LLISSE

- **Investigation 2.1.C** - Constrain the near surface atmosphere conditions to constrain surface-atmosphere exchange and buffering.
  
  T,P,x on descent and lander
GOAL 3. UNDERSTAND THE MECHANISMS OF GEOLOGIC ACTIVITY AND IF VENUS IS ACTIVE TODAY

**Objective 3.1:** Does Venus show evidence of a current or past plate tectonic regime?

- **Investigation 3.1.A - Constrain the interior structure of the crust, mantle, and core.**
  
  Gravity tracking of Orbiter | Infrasound on Balloon | Magnetometer on Lander and multiple SmallSats

- **Investigation 3.1.B - Characterize tectonic features & establish stratigraphic relationships**

  SAR on Orbiter | Descent Imaging
GOAL 3. UNDERSTAND THE MECHANISMS OF GEOLOGIC ACTIVITY AND IF VENUS IS ACTIVE TODAY

Objective 3.2: How tectonically and volcanically active is Venus today?

• **Investigation 3.2.A - Look for present day seismicity.**  
  Gravity tracking of orbiter | Infrasound on balloon

• **Investigation 3.2.B - Look for present day volcanism.**  
  Infrasound on balloon | Mass spec on descent and balloon

• **Investigation 3.2.C - Determine the composition of non-H2SO4 particulates.**  
  Mass spec on descent and balloon
### SOME MAJOR EARLY TRADES

<table>
<thead>
<tr>
<th>Trade</th>
<th>Consider…</th>
</tr>
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<tbody>
<tr>
<td>Many general instrument trades e.g., How to measure ground motion</td>
<td>Seismometer on lander vs. airglow or infrasound (orbiter/balloon). VFM will consider with help from experts.</td>
</tr>
<tr>
<td>Lander sampling mechanism/instrumentation Instrument(s) determine if ingestion is necessary</td>
<td>Raman/LIBS/PIXL/XRD/SAM/NGRS/Mössbauer - TRL and risk</td>
</tr>
<tr>
<td>Direct Entry vs Deploy from Orbit</td>
<td>Landing site knowledge/risk</td>
</tr>
<tr>
<td>How to accommodate the selection of Venus missions prior to Flagship?</td>
<td>Discussions with proposed mission teams and community. Can we outline several scenarios in report.</td>
</tr>
</tbody>
</table>