Alaska Landslide Tsunami Sources

- For landslides, capturing the geometry of the slide mass and the dynamics of the slide motion are important to a tsunami source characterization.
  - Once an initial slide geometry is specified, which would include a description of the failure surface, the evolution of the landslide downslope can be estimated with a number of methods.
  - Similar to the description of slip in seismic sources, these methods vary from simple (e.g. solid body motion of a non-deforming mass) to complex (e.g. temporally-staggered failure of a deforming, multi-material slide with water/sediment entrainment).
  - The relative importance of these different slide motion models is dependent on the geophysical character of the particular source in question.
- To understand the tsunami hazard for a particular landslide source, therefore, it becomes essential to quantify the likely or potential range of possible initial geometry and failure motion combinations of the slide (Logic Tree!)
- In this Powell activity, the recurrence rate of the slide is NOT a property that is directly sought.
  - With knowledge of the slide location and its volume, a recurrence rate could be calculated with a comprehensive database of previous events; however, such a database does not yet exist.
  - Alternatively, one might correlate the slide source with a particular trigger, such as a seismic event, for which a recurrence rate is more readily determined.

Approaches for Generating Waves Directly from Landslide Motion

Modeling the Generated Waves

- For a coupled slide+waves forecast, one would need to:
  1. Decide on a slide location – a particular area known to have previous slides or expected to have slides in the future
  2. Decide on the geometry of the mass movement – not just volume, but 2D slip surface as well
  3. Choose a mass movement failure mechanism (e.g. rotational, translational) and/or choose a slide material behavior model (e.g. solid body motion, Bingham)
  4. Choose the coefficients that govern the material behavior model (e.g. drag coefficient, threshold shear stress formulation coefficients)
  5. Based on geometric properties of slide (throughout its evolution) choose an appropriate hydrodynamic model to accurately model the "important" wave frequencies
  6. Develop a bathy / topo grid for propagation of the waves away from the source, and choose a still water level (high tide, sea level rise)
  7. Specific a bottom friction factor (probably spatially variable) to account for energy dissipation during shallow and overland tsunami flow

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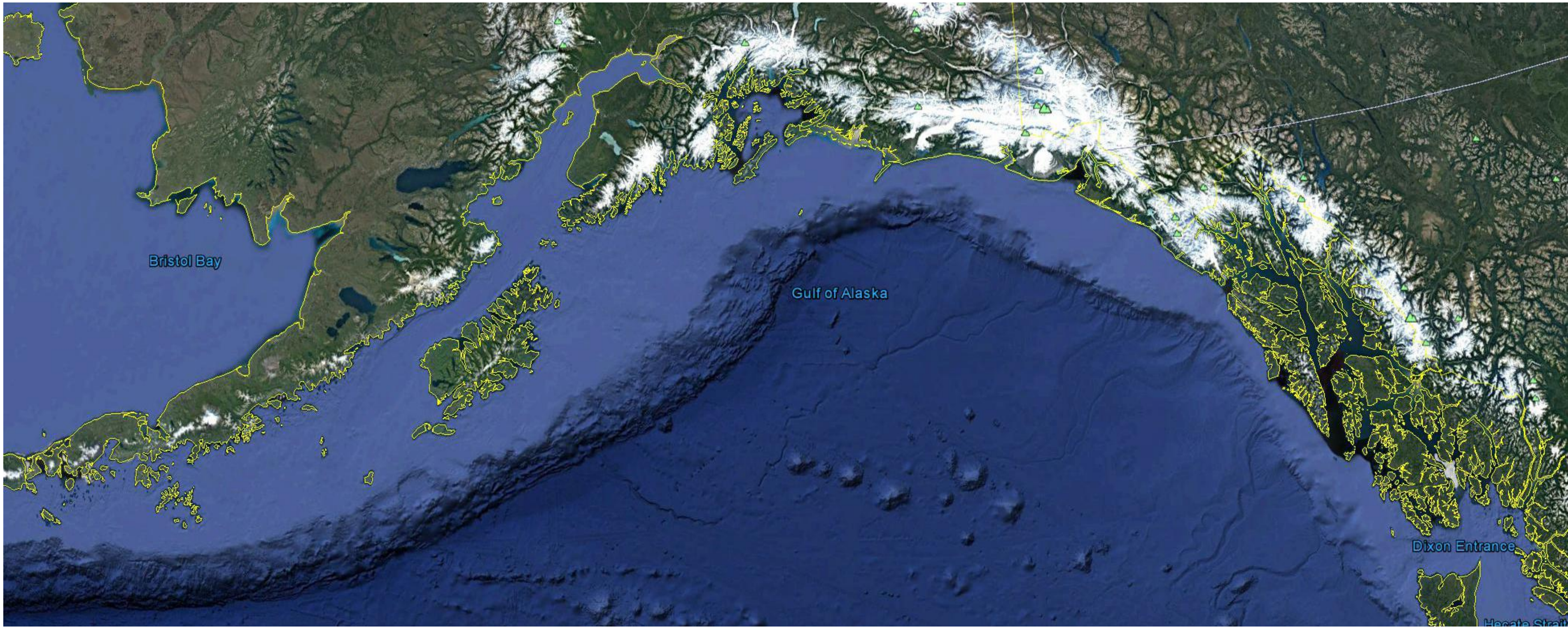
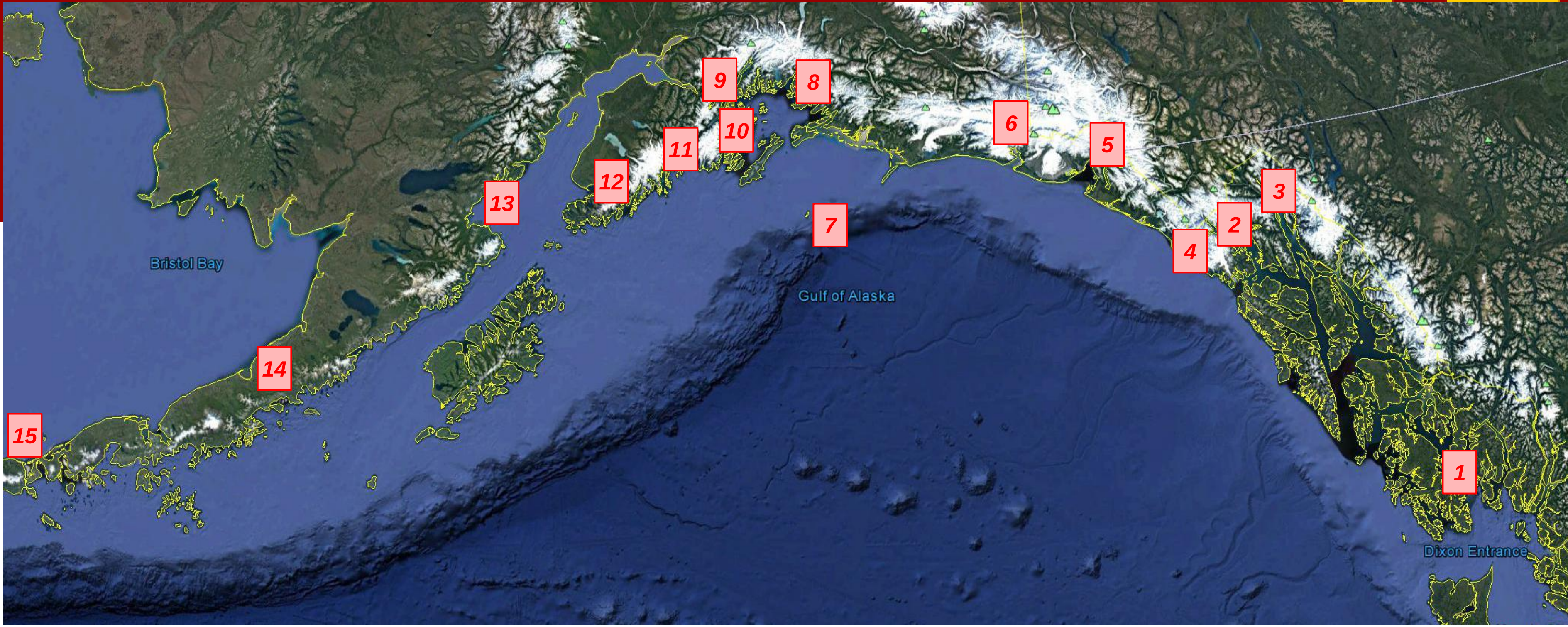
NEED TO HAVE DISCUSSION AND PRIORITIZATION OF WHICH SLIDES TO EXAMINE





1. Ketchikan
2. Glacier Bay
3. Skagway
4. Lituya Bay
5. Hubbard Glacier / Yakutat
6. Icy Bay
7. Shelf break slide
8. Valdez
9. Whittier
10. Chenega
11. Seward
12. Grewingk Glacier/Lake
13. Mount St. Augustine Volcano
14. Aniakchak Volcano
15. Farther to the west: Unimak Island, volcanic sources

- What sources are missing?
- Should/can we add hypothetical sources closer to population centers, or how far can we move historical slides to "new" locations?
- How can we associate slides of various volumes and locations with triggers (that may have an established recurrence)?
- Group slides with "similar" geophysical character?
- Volcanic sources possibly relevant to hazard in other States?
- During the Powell activity, it is likely that the group will only be able to examine in detail 2-4 different slides. How to prioritize?

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COVERED WITH A LOGIC TREE

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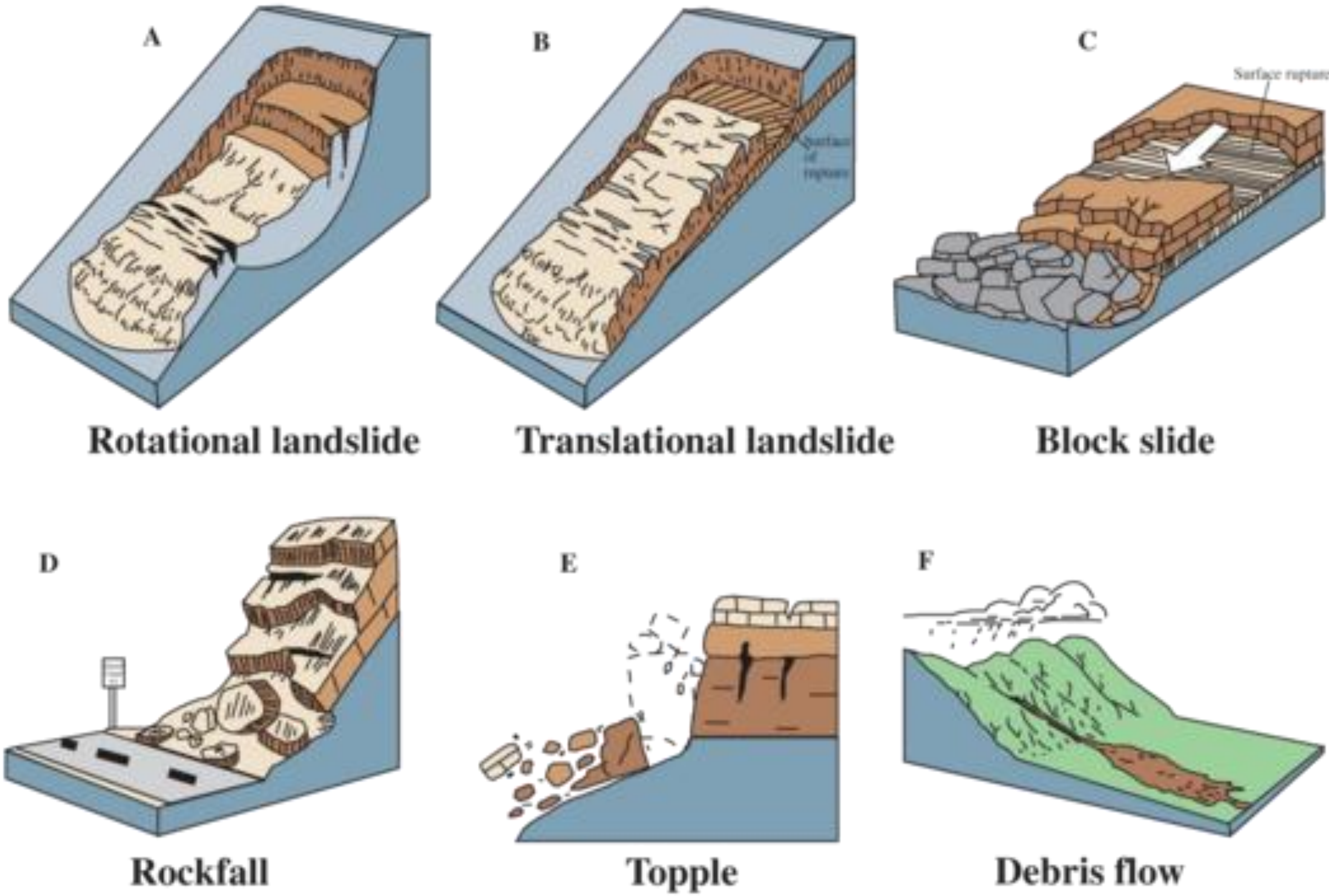
Approaches for Generating Waves Directly from Landslide Motion

Types of Failures

Mass movements can take a wide variety of forms, and each will have different tsunamigenic efficiency and potential



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Approaches for Generating Waves Directly from Landslide Motion

<u>Types of Failures</u>

Mass movements can take a wide variety of forms, and each will have different tsunamigenic efficiency and potential

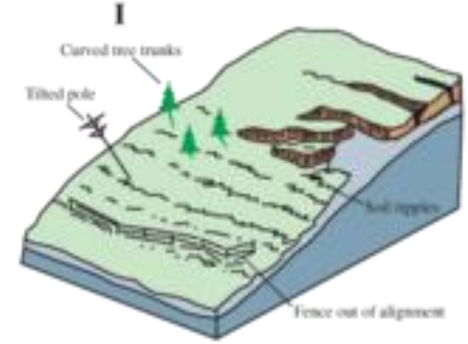
G

Debris avalanche

H

Earthflow

I



Creep

J

Lateral spread

Mass movements that are "shallow" (horizontal length scale much greater than local depth), "coherent" (fails as a single mass, not a group of smaller pieces), "fast" (time scale on the order of the generated wave period), and involve strong VERTICAL ACCELERATION will be the most tsunamigenic sources

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Landslide Source Logic Tree

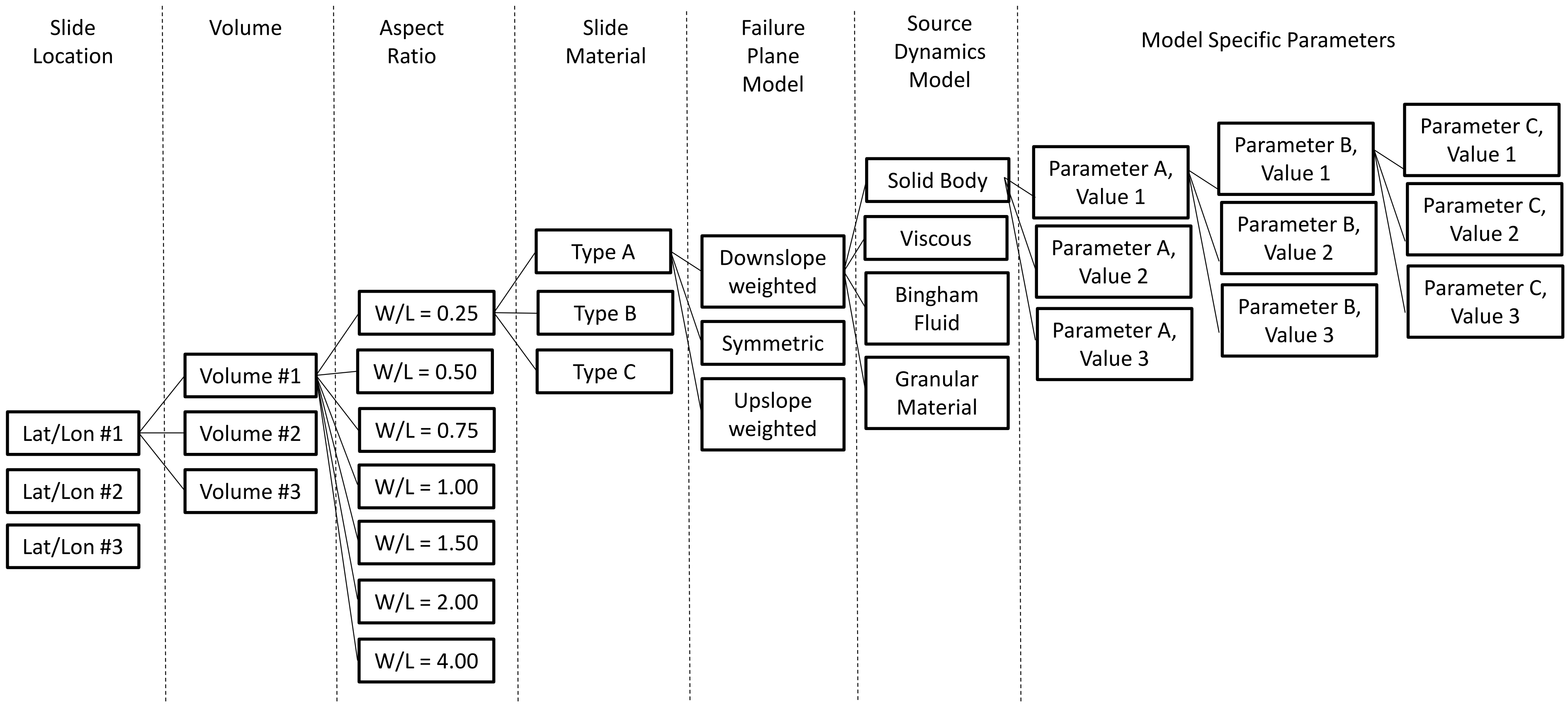
Develop for a single source location; a stochastic-scenario approach

- Attempt to generate a tree structure that is extensible to both submerged and subaerial slide masses

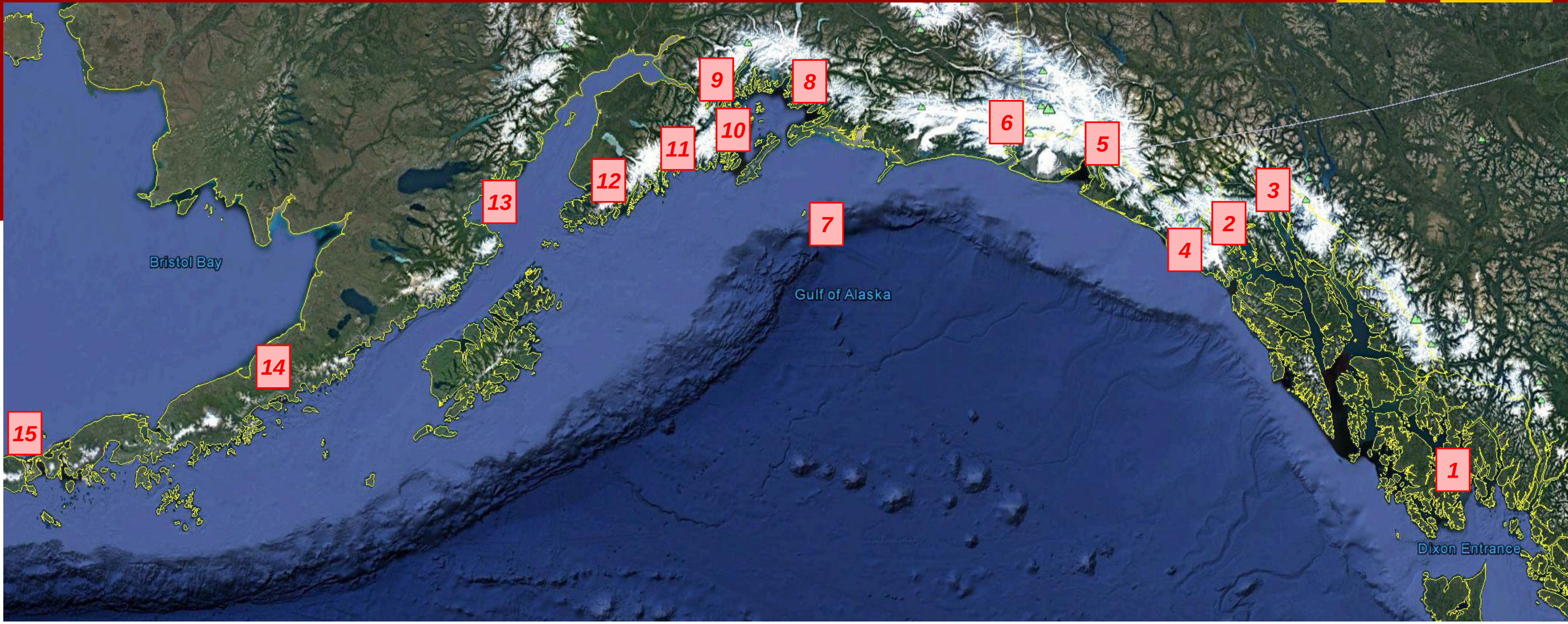
Needed information

1. Geographic location of slide mass centroid
   - Set of lat/lon with weighting functions for each location to indicate the relative likelihood of that location
2. Volume of slide mass
   - Set of volumes with weighting functions, or a distribution; the breadth of potential volumes limits the scope of the stochastic-scenario approach
   - Can be dependent on location (variable branch) or uniform across all locations (universal branch)
   - IF we had a robust catalog of landslide events, the information in 1 and 2 would be enough to yield a recurrence rate
3. Slide horizontal aspect ratio
   - Set of slide width to length ratios, with weighting functions
4. Material / Composition of slide material
   - Set of soil properties; used by source model
   - Likely would require a number of individual branches
5. Failure plane model
   - Provides the distribution of slide thickness along the slide width
6. Source dynamics model
   - Set of models describing the landslide behavior with weighting functions
   - Most models will have additional branches to describe specific evolution (parameters that are needed by all or most models should be specified in the material/composition branches)

Landslide Source Logic Tree



Powell workshoppers will need to determine which boxes to include in the LT, the parameter values in each box, and the box weightings



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