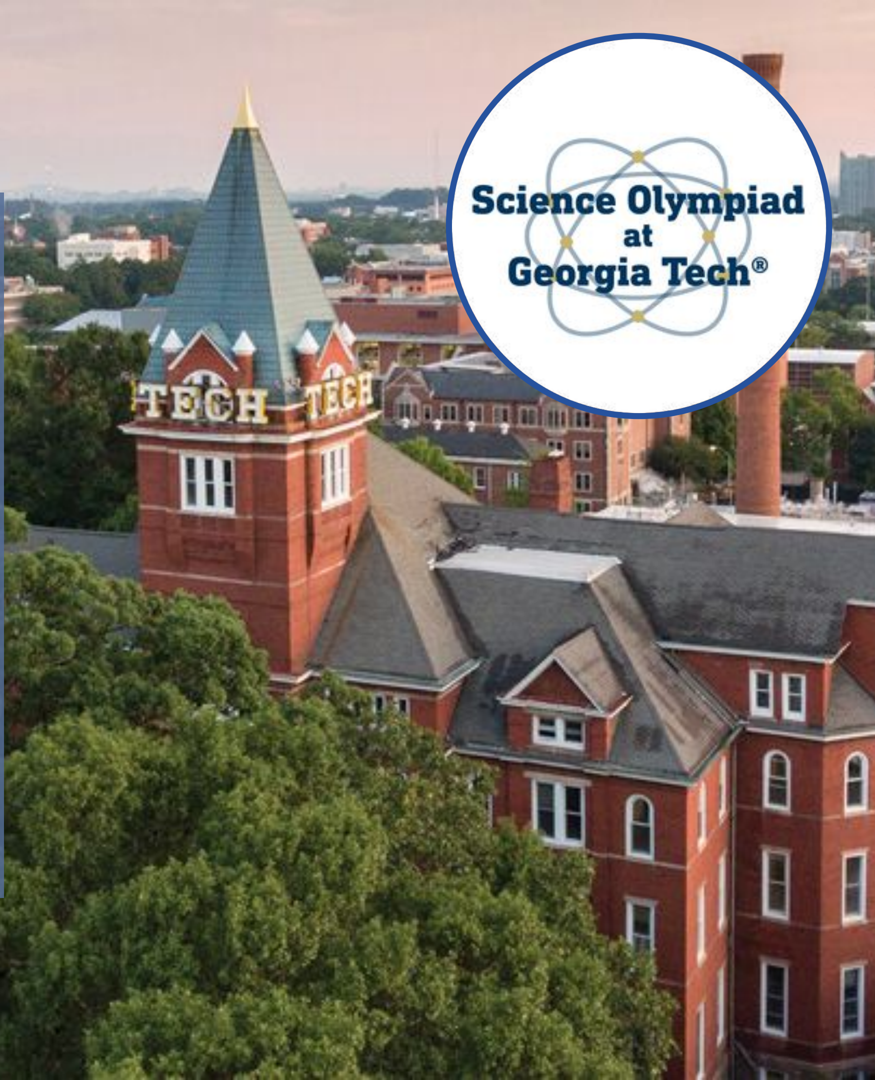
Dynamic Planet

Division B & C

Georgia Tech Event Workshop Series
2024-25



Science Olympiad at Georgia Tech®

01 RULES SHEET

02 DIFFICULT TOPICS

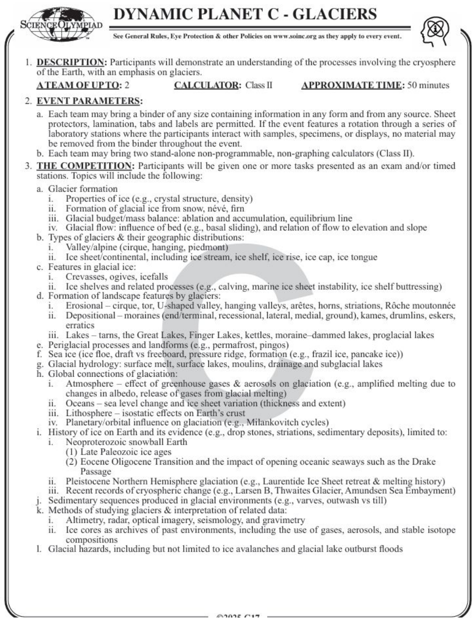
03 COMMON QUESTIONS

04 TIPS FROM A VETERAN

05 OTHER FREE RESOURCES

The Rules Sheet

- Binder Event: All Notes/Material **must** be hole-punched and placed in the binder rings
  - Having material outside the binder rings (loose sheets, etc. is **not acceptable**)
  - Please have all material ready the night before the competition as generally hole-punchers are rare at the competition site.
- **Non-Graphing** Calculators Allowed
- Topic of the Year: **Glaciers**



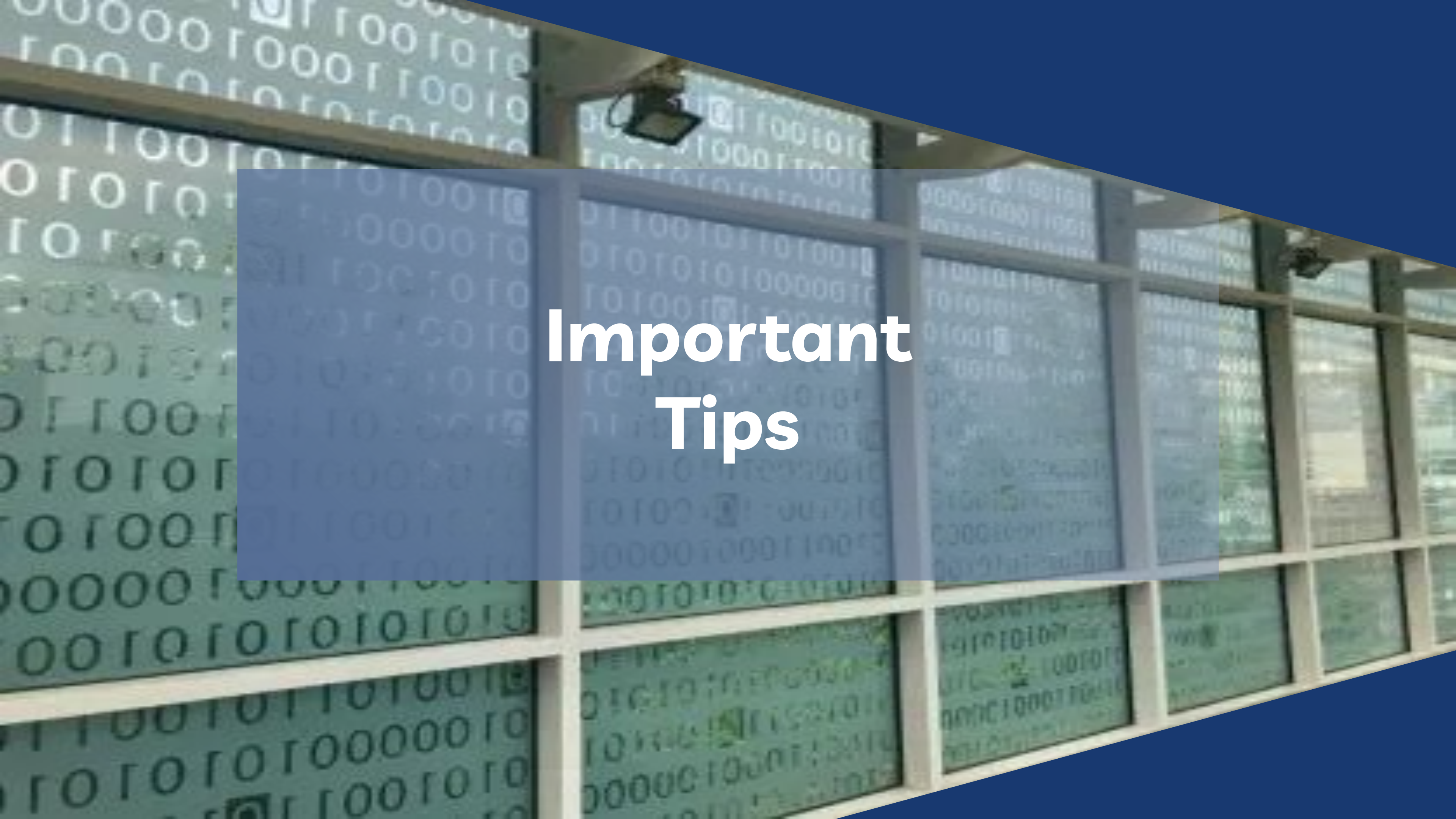
DYNAMIC PLANET C - GLACIERS

See General Rules, Eye Protection & other Policies on www.soinc.org as they apply to every event.

1. **DESCRIPTION:** Participants will demonstrate an understanding of the processes involving the cryosphere of the Earth, with an emphasis on glaciers.

   A TEAM OF UP TO: 2 **CALCULATOR:** Class II **APPROXIMATE TIME:** 50 minutes
2. **EVENT PARAMETERS:**
   a. Each team may bring a binder of any size containing information in any form and from any source. Sheet protectors, lamination, tabs and labels are permitted. If the event features a rotation through a series of laboratory stations where the participants interact with samples, specimens, or displays, no material may be removed from the binder throughout the event.
   b. Each team may bring two stand-alone non-programmable, non-graphing calculators (Class II).
3. **THE COMPETITION:** Participants will be given one or more tasks presented as an exam and/or timed stations. Topics will include the following:
   a. Glacier formation
      i. Properties of ice (e.g., crystal structure, density)
      ii. Formation of glacial ice from snow, névé, firn
      iii. Glacial budget/mass balance: ablation and accumulation, equilibrium line
      iv. Glacial flow: influence of bed (e.g., basal sliding), and relation of flow to elevation and slope
   b. Types of glaciers & their geographic distributions:
      i. Valley/alpine (cirque, hanging, piedmont)
      ii. Ice sheet/continental, including ice stream, ice shelf, ice rise, ice cap, ice tongue
   c. Features in glacial ice:
      i. Crevasses, ogives, icefalls
      ii. Ice shelves and related processes (e.g., calving, marine ice sheet instability, ice shelf buttressing)
   d. Formation of landscape features by glaciers:
      i. Erosional – cirque, tor, U-shaped valley, hanging valleys, arêtes, horns, striations, Rôche moutonnée
      ii. Depositional – moraines (end/terminal, recessional, lateral, medial, ground), kames, drumlins, eskers, erratics
      iii. Lakes – tarns, the Great Lakes, Finger Lakes, kettles, moraine–dammed lakes, proglacial lakes
   e. Periglacial processes and landforms (e.g., permafrost, pingos)
   f. Sea ice (ice floe, draft vs freeboard, pressure ridge, formation (e.g., frazil ice, pancake ice))
   g. Glacial hydrology: surface melt, surface lakes, moulins, drainage and subglacial lakes
   h. Global connections of glaciation:
      i. Atmosphere – effect of greenhouse gases & aerosols on glaciation (e.g., amplified melting due to changes in albedo, release of gases from glacial melting)
      ii. Oceans – sea level change and ice sheet variation (thickness and extent)
      iii. Lithosphere – isostatic effects on Earth's crust
      iv. Planetary/orbital influence on glaciation (e.g., Milankovitch cycles)
   i. History of ice on Earth and its evidence (e.g., drop stones, striations, sedimentary deposits), limited to:
      i. Neoproterozoic snowball Earth
         (1) Late Paleozoic ice ages
         (2) Eocene Oligocene Transition and the impact of opening oceanic seaways such as the Drake Passage
      ii. Pleistocene Northern Hemisphere glaciation (e.g., Laurentide Ice Sheet retreat & melting history)
      iii. Recent records of cryospheric change (e.g., Larsen B, Thwaites Glacier, Amundsen Sea Embayment)
   j. Sedimentary sequences produced in glacial environments (e.g., varves, outwash vs till)
   k. Methods of studying glaciers & interpretation of related data:
      i. Altimetry, radar, optical imagery, seismology, and gravimetry
      ii. Ice cores as archives of past environments, including the use of gases, aerosols, and stable isotope compositions
   l. Glacial hazards, including but not limited to ice avalanches and glacial lake outburst floods

Important Tips



Binder Organization

- **Organization** and **Formatting** is Key to a Successful Binder
  - **Images**
  - Avoid **Walls of Text**, try to summarize notes in bullet points
- Base Chapter off of Guidelines Headings and expand upon those sections
  - **Don't just copy information off the wiki** → Okay as a starting point, but please ensure that you are familiar with the topics as you are adding them into the binder.
- **Common Mistake:** Not knowing the information behind the binder
  - Binders should be used as a **reference** not as a textbook that you only start looking at the morning of the exam.
  - Should have a good enough familiarity with the topics to reference certain pages on a minute's notice

Source Material

Content Review:

- SciOLY Wiki – #1 resource for basic event overview & topics to know

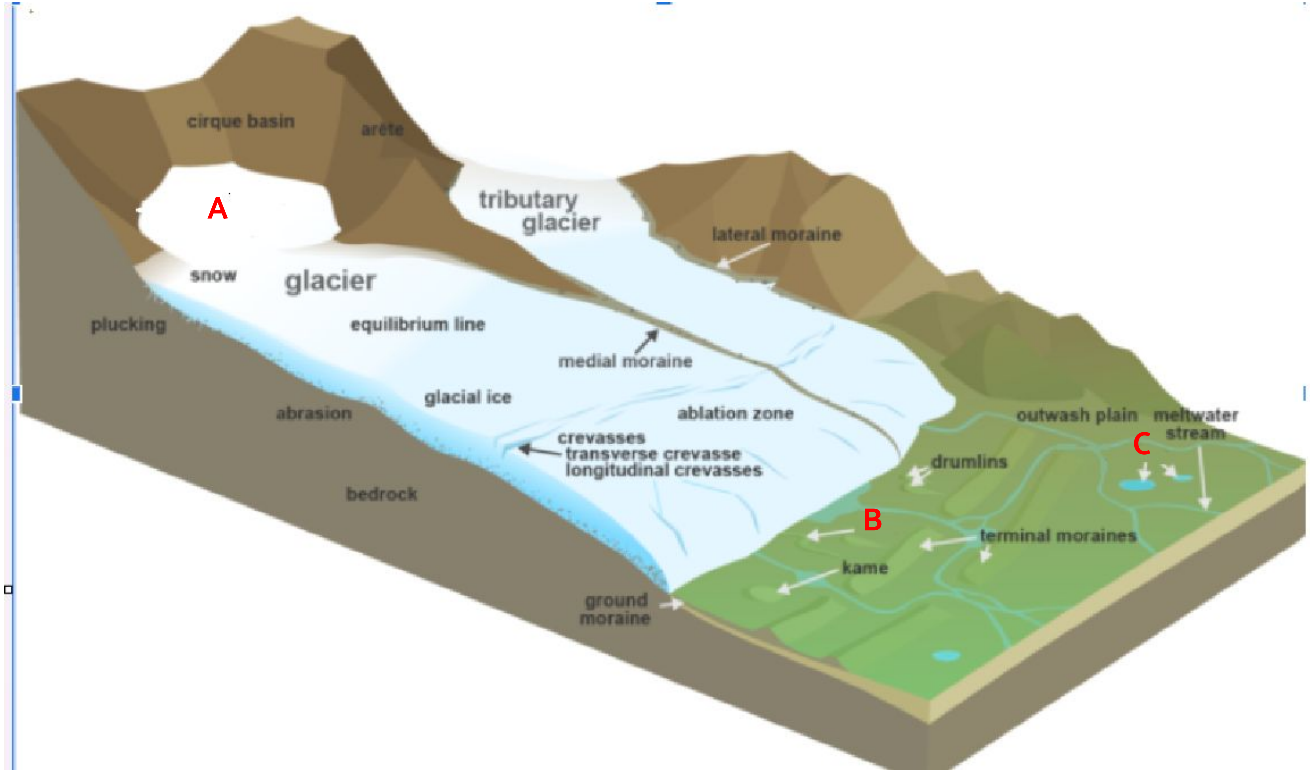
Practice Questions → Main way to Prepare

- Approach to Studying:
  - Look at a Question → See if you can answer it without having to reference notes
  - Research that topic in detail → Wikipedia, Britannica, USGS, Videos, GPT4o
    - **Learn the content**
    - Place Images, materials that you find into your find under your chapter headers **using your own words**

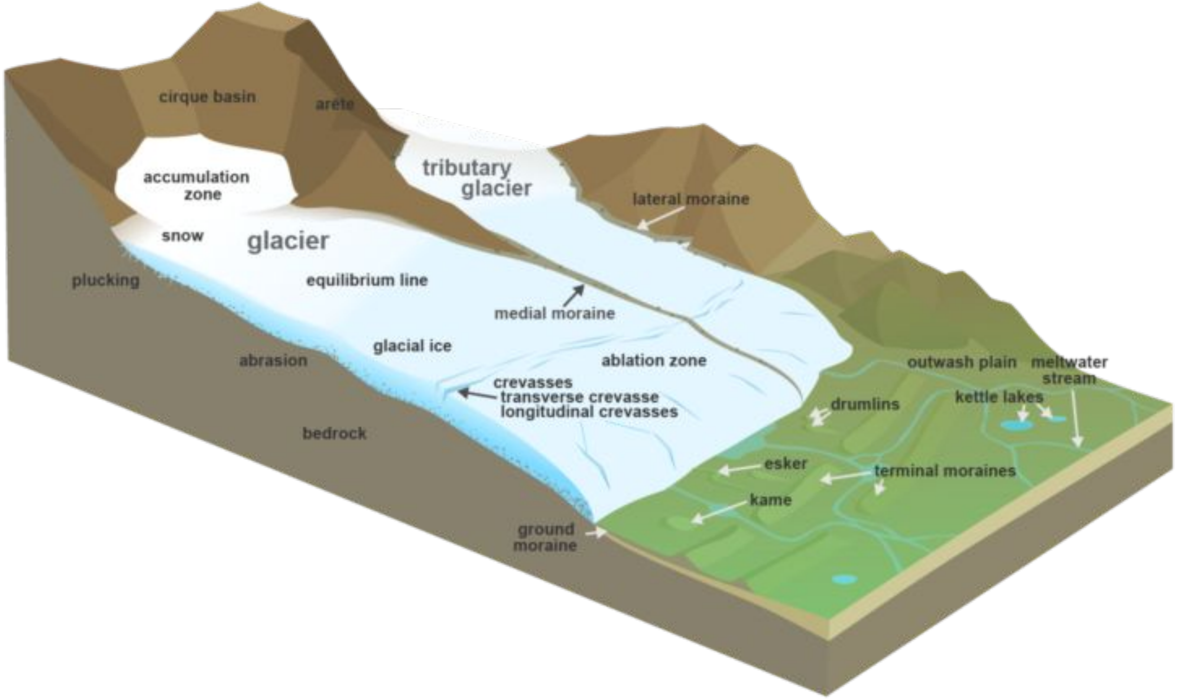
QUESTION REVIEW

All of the following questions have been pulled from past YJI exams (which can be found on our website) or the Text Exchange on SciOly Wiki

Question 1: Simple Recall



Question 1: Simple Recall



Question 2: Qualitative Analysis

The following questions refer to Fig. 1.

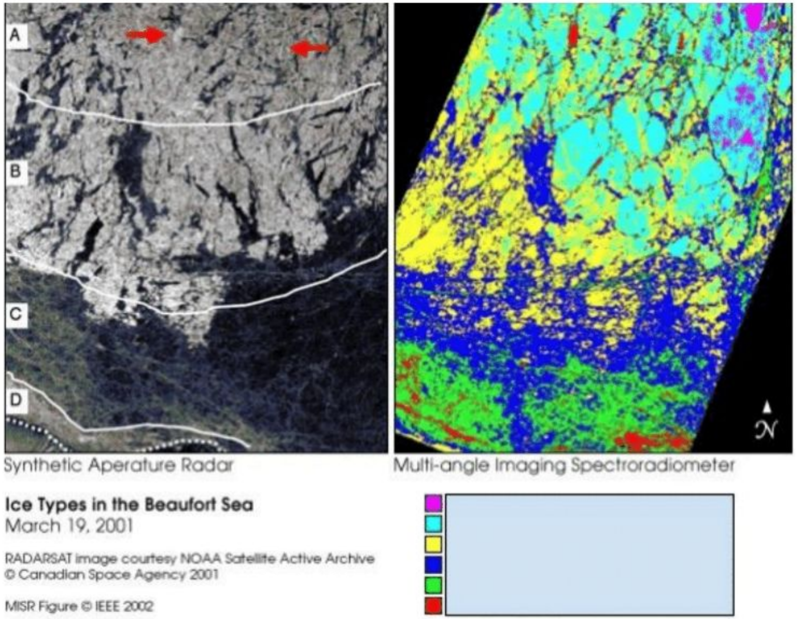
The left image was created by Synthetic Aperture Radar (SAR) and the right image was created by Multi-angle Imaging SpectroRadiometer(MISR).

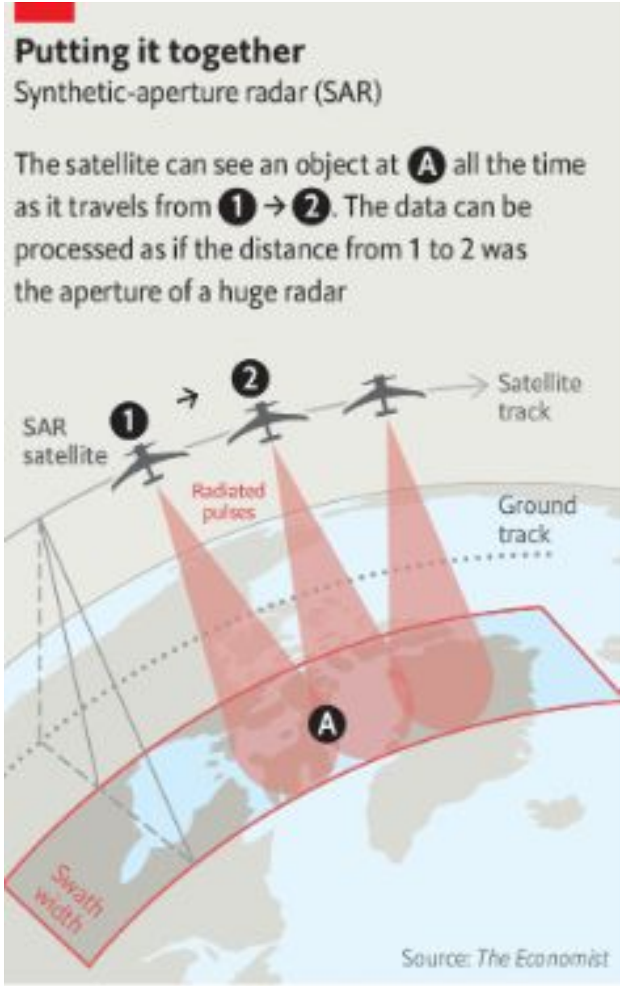
Both images are of ice in the Beaufort Sea, Alaska.

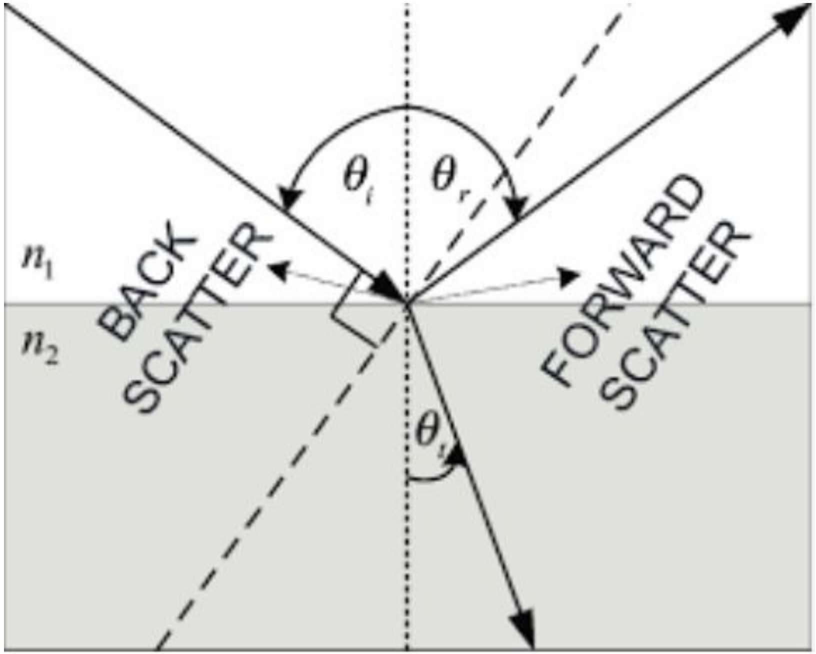
- Ice classification in this image is based on what two values? So then, why is section C of the left image nearly black though it is still ice?

- What type of ice does the turquoise blue color represent?

<Princeton Science Olympiad Invitational – 2019>




Putting it together
Synthetic-aperture radar (SAR)
The satellite can see an object at A all the time as it travels from 1 → 2. The data can be processed as if the distance from 1 to 2 was the aperture of a huge radar
SAR satellite
1
2
Satellite track
Radiated pulses
Ground track
A
Swath width
Source: The Economist


θ_i
θ_r
n_1
n_2
BACK SCATTER
FORWARD SCATTER
θ_t

Question 2: Qualitative Analysis

SAR is sensitive to the physical texture of the ice, detecting ridges, cracks, and deformations.

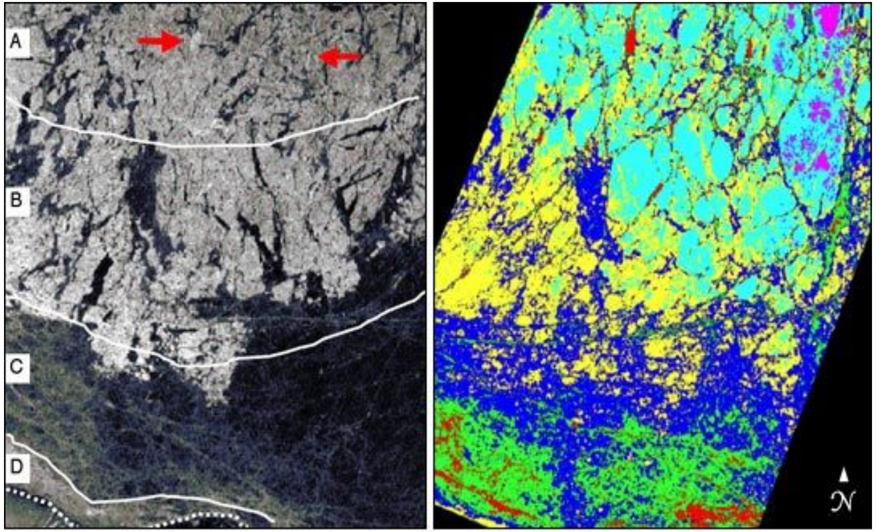
MISR detects how much sunlight is reflected, influenced by surface composition and the presence of snow or melt ponds.

Ice classification in this image is based on what two values? So then, why is section C of the left image nearly black though it is still ice?

Forward scatter and backscatter; younger ice predominately forward scatters light,resulting in little to no signal being reflected back to the sensor, which makes the region nearly black to the sensor

What type of ice does the turquoise blue color represent?

Multi-Year Ice



Synthetic Aperature Radar

Multi-angle Imaging Spectroradiometer

Ice Types in the Beaufort Sea
March 19, 2001

RADARSAT image courtesy NOAA Satellite Active Archive

- cloud
- multi-year ice
- mostly multi-year ice, some first-year ice
- mostly first-year ice
- mostly first-year and younger ice
- mostly thin, younger ice

Question 3: Quantitative Analysis

Consider a small alpine glacier of thickness 50 m, average density of 917 kg/m^3 and a slope of 10°.

What is the normal stress at the base of the glacier? Assume $g = 9.8$ m/s^2.

What is the shear stress at the base of the glacier?

<MIT Invitational 2019>

Question 3: Quantitative Analysis

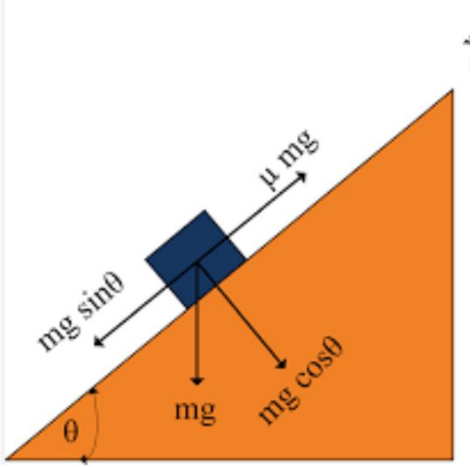
Consider a small alpine glacier of thickness 50 m, average density of 917 kg/m^3 and a slope of 10°.

What is the normal stress at the base of the glacier? Assume $g = 9.8\ m/s^2$.

What is the shear stress at the base of the glacier?

normal stress = density * height * g * cos(angle) = 917 * 50 * 9.8 * cos(10) = 442.5 kPa

shear stress = density * height * g * sin(angle) = 917 * 50 * 9.8 * sin(10) = 78 kPa



Tips from a Veteran

- Don’t blindly copy content into your binder → **Learn & Understand it**
- Start with Fundamentals by learning through SciOly Wiki → Proceed to harder topics by **researching** each topic online and writing **your own notes for it**
- If you come across a question, which you may be unfamiliar, make an educated guess based on what the problem gives you and based on what you know
- **Practice:** Look at <u>all tests from prior year</u> (DP Changes topics but look at priori years with similar topics:
  - Glaciers: 2019, 2014, 2013, 2006, 2005
- **Have Fun!** Science Olympiad Competitions are a great way to interact with students from other High/Middle Schools and explore several fun events, most importantly **enjoy** the material, and don’t stress too much about fitting every little fact into your binder.

THANKS!