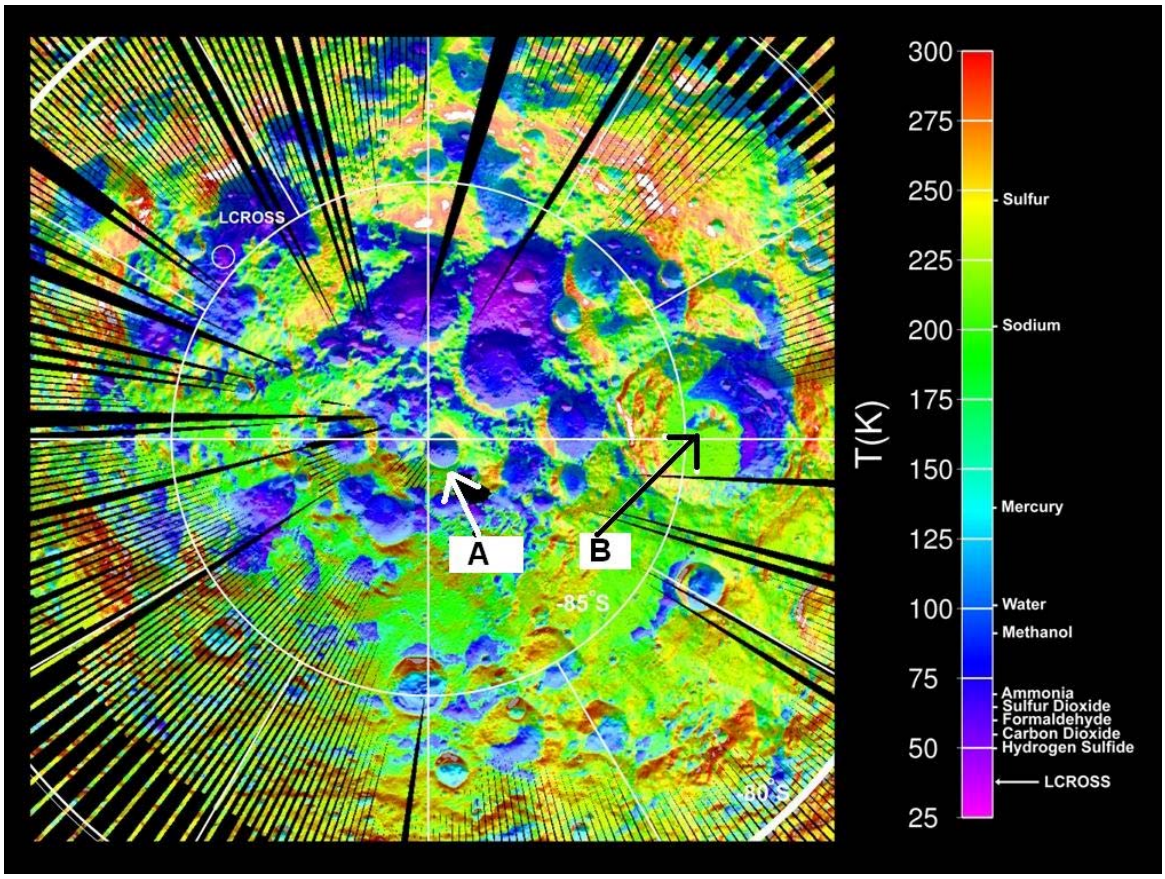

The Lunar Reconnaissance Orbiter (LRO) has recently created the first surface temperature map of the south polar region of the moon using date taken between September and October, 2009 when south polar temperatures were close to their annual maximum values. The colorized map shows the locations of several intensely cold impact craters that are potential cold traps for water ice as well as a range of other icy compounds commonly observed in comets. The approximate maximum temperatures at which these compounds would be frozen in place for more than a billion years is shown on the scale to the right. The LCROSS spacecraft was targeted to impact one of the coldest of these craters, and many of these compounds were observed in the ejecta plume. *(Courtesy: UCLA/NASA/JPL)*

Problem 1 - The width of this map is 500 km. What are the diameters of Crater A (Shackleton) and Crater B (Amundsen) in kilometers?

Problem 2 - In which colored areas might an astronaut expect to find conditions cold enough to recover all of the elements and molecules indicated in the vertical temperature scale to the right?

Problem 3 - The Shackleton Crater (Crater A) is cold enough to trap water and methanol. From Problem 1, and assuming that the thickness of the water deposit is 100 meters, and occupies 10% of the volume of the circular crater, how many cubic meters of water-ice might be present?

Problem 1 - The width of this map is 500 km. What are the diameters of Crater A (Shackleton) and Crater B (Amundsen) in kilometers?

Answer: If the page is printed as 8.5 x 11-inches, the width of the colorized image is 106 mm wide, which corresponds to 500 km, so the image scale is 500 km/106mm = 4.7 km/mm. Crater A has a diameter of 4.4 mm so its actual diameter is 4.4 mm x (4.7 km/mm) = **20 kilometers**. Crater B has a diameter of 34 mm, so its actual diameter is about 34 x 4.7 = **160 kilometers**.

Problem 2 - In which colored areas might an astronaut expect to find conditions cold enough to recover all of the elements and molecules indicated in the vertical temperature scale to the right?

Answer: Students should note that all compounds above a given temperature will be present in conditions cold enough to 'trap' these compounds. **Areas where the temperature is below 50 K will be cold enough to trap all of the identified compounds. These are areas colored lavender at the bottom of the temperature scale, and in areas similar to where LCROSS impacted.**

Problem 3 - The Shackleton Crater (Crater A) is cold enough to trap water and methanol. From Problem 1, and assuming that the thickness of the water deposit is 100 meters, and occupies 10% of the volume of the circular crater, how many cubic meters of water-ice might be present?

Answer: The diameter of the circular crater is 20 km or 20,000 meters, so its radius is 10,000 meters. The area of the crater is then $A = \pi\ (10{,}000)^2 = 314{,}000{,}000$ meters^2. Since the thickness of the deposit is perhaps 100 meters, the volume of this disk of material is V = 100 meters x 314,000,000 meters^2 = 3.1×10^{10} meters^3. Since only 10% of this is hypothetically water-ice, the ice volume is just 0.1V or **3.1×10^9 meters^3.**

Note: This ice volume is similar to a small glacier!