2002 Colorado State Science Olympiad **The Solar System, Division B**
Lunar Explorer Record your answers on the Response Sheet.

The year – 2058. The first permanent, commercial lunar colonies are about to become reality. Establishing permanent settlements on the lunar surface will, within a few short years, nearly obliterate 4.5 billion years of geologic history. The final opportunity to study, photograph and record the lunar surface as it presently appears is at hand!

The US Congress has authorized an expenditure of two billion dollars to train a highly qualified team of lunar geologists. These explorers will travel to the Moon in a last ditch effort to complete a thorough and accurate study of its surface. The results of this final survey will undoubtedly serve as a basis for numerous future theories of how our Earth, its Moon and the solar system were originally formed.

You are one of hundreds of successful applicants chosen to demonstrate their knowledge of extraterrestrial planetary and satellite science in hope of being chosen for this historic role. This is it! The exams have been distributed! A final "good luck" from the proctor with a comment that the test booklets may be opened is uttered. Anxiously, you flip the cover sheet to reveal the first questions. Will your long hours of study pay off? Or will you part in frustration and disappointment? You will soon know.

The most prominent lunar features are circular craters formed by either **1** (a. meteor; b. meteorite; c. meteoroid) impact or volcanic activity. It appears logical to conclude that bombardment by rocks from space would have resulted in a nearly equal distribution of craters. Photos reveal, however, that the distribution of craters is not equal. To explain this, scientists believe certain areas of the lunar surface to be **younger** than others, with the younger areas possessing **2** (a. fewer; b. more abundant) craters per given area as illustrated in **3** (a. Figure 1; b. Figure 2) below. This uneven distribution of craters may be due to more recent geologic activity resulting in a resurfacing of areas originally containing older craters.

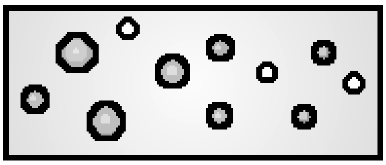
Figure 1

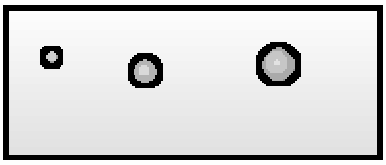
Figure 2

Superposition, the altering of an existing feature by a more recent event, is extremely useful in determining the relative ages of two or more "overlapping" features. The crater labeled A in Figure 3, for example, is **4** (a. younger; b. older) than the crater labeled B. The crater labeled A in Figure 4 is **5** (a. younger; b. older) than the crater labeled B.

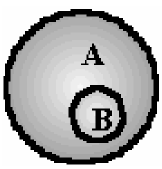

Figure 3

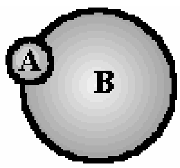

Figure 4

When impacted by rocks from space, lines of debris are tossed outward forming “rays” of material which, due to there being no atmosphere on the Moon, may remain for millennia unless disturbed and/or blanketed by falling space rocks and dust particles. Through the use of superposition, we can determine the age of the craters in Figure 5 from **oldest to youngest** as **6** (a. ABC; b. CBA; c. BAC; d. ACB; e. no correct choice is provided).

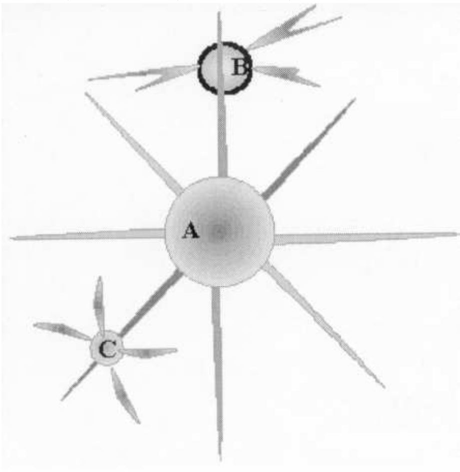

Figure 5

In addition to rays created as material is ejected from the crater, larger rocks may be blasted up and outward to form a circular pattern of secondary craters. At the time of impact, large quantities of smaller dust particles may fall to the surface covering any features that may have existed prior to impact. This results in a smooth-appearing, ring-like surface between the central crater and the ring of secondary craters.

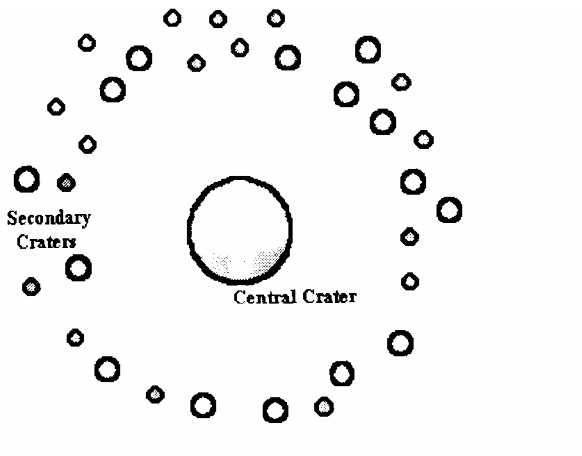

Figure 6

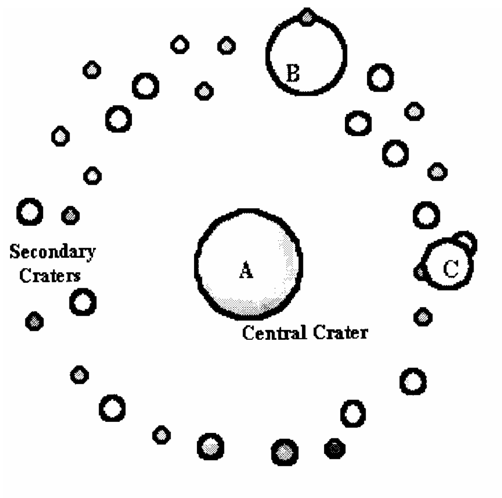

Figure 7

Superposition may be used to determine the relative ages of craters located within a ring of secondary craters. As illustrated in Figure 7 below, the relative ages of craters A, B and C – **ordered from oldest to youngest** – is **7** (a. ABC; b. BCA; c. BAC; d. CAB; e. no correct choice is provided).

Determining the relative ages of the two impact craters found in Figure 8 may prove to be a little more difficult. Close examination and careful analysis, however, will reveal that (a. Crater A; b. Crater B) is the **youngest**.

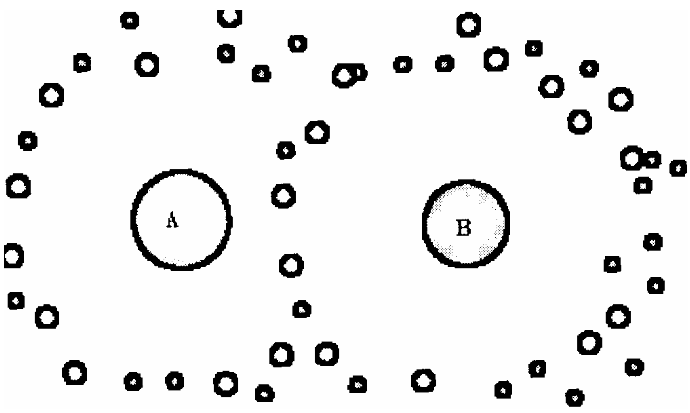

Figure 8

Although not addressed during this lesson, crater walls and other lunar features may eventually erode due to the constant downpour of small dust particles. Craters and mountains may flatten as the Moon's gravity gradually pulls them downward. This eroding and flattening effect may also provide clues as to the relative ages of lunar features.

Although impact cratering appears to be the most prominent agent of change on the lunar surface, other activities do come into play – mainly faulting and lava flows. Lava flows may cover previously existing features. Internal pressures may cause cracks and shifting of the Moon's surface. The absence of rays may indicate that space dust has for eons disturbed the rays since the crater was first formed. Thus, a crater with little or no sign of secondary craters or rays may be older than craters exhibiting such features.

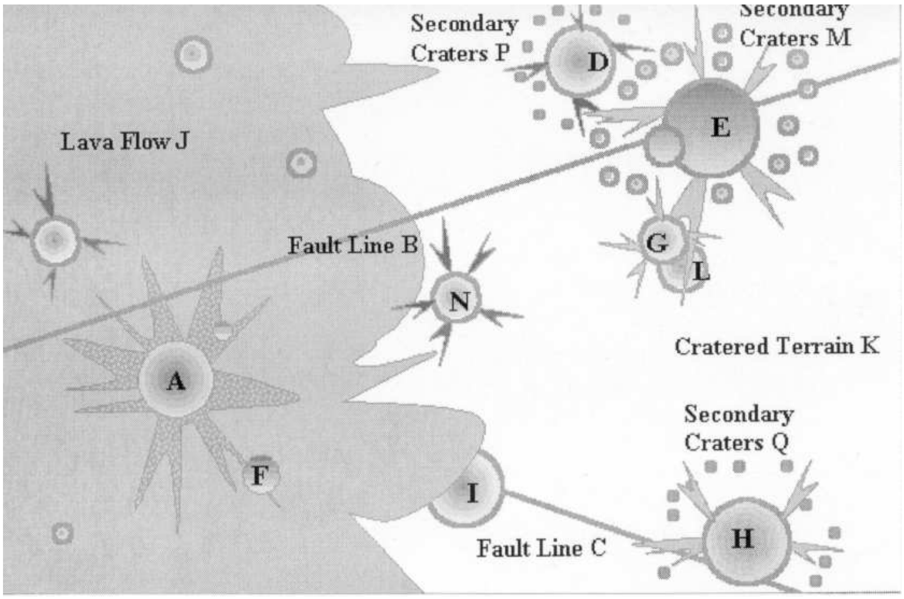

Figure 9

Directions: On your answer sheet, for each set of features listed circle the letter identifying the **oldest** feature on the imaginary lunar surface illustrated in Figure. [5 points will be awarded for each correct response.]

9. **I J C H**

10. **B E C D**

11. **P M G E**

12. **N A F J**

20-point question: This last exercise is to be completed in the rectangular area provided on your answer sheet. Create your own lunar landscape with overlapping features so they may be dated according to relative age employing the principle of superposition. On the lined page, describe each step in the sequence of events that "created" this lunarscape. Be certain to label the various events and include identifying letters or numbers in the text of your narrative.