MARS EXPLORATION 2050: HUMAN AND ROBOTIC EXPLORATION INTERTWINED. B. M. Jakosky, Univ. of Colorado (LASP, U. of Colorado, 3665 Discovery Dr., Boulder, CO 80303, bruce.jakosky@lasp.colorado.edu).

Introduction: Space exploration over the next thirty years is likely to include increased human involvement and to have increased collaboration between human and robotic missions. One of the options being discussed for human missions is Mars. Why Mars? "People in space" has always been about reaching beyond our grasp and exploring the unknown, and a target such as Mars is simultaneously very difficult and very doable. In addition, Mars allows us to explore profound and fundamental scientific questions – how do planets form and evolve, what factors control the evolution of planets and of climate, and is there life beyond the Earth.

The Science Is Important: Mars exploration brings together most aspects of our scientific goals in exploring the solar system. It gets at our understanding of planetary formation, interior/thermal history, climate evolution, interaction with the Sun and the solar wind, and, of course, the origin and evolution of life. Combining these questions at one object has made Mars a central focus in exploring our solar system. It is the place that best combines a reasonable likelihood of having (or having had) life with relatively straightforward accessibility by spacecraft.

The question of whether Mars has life might be answered in part by the ESA/Russian Trace Gas Orbiter, by *in situ* analysis, or by sample return in the next decade. However, a simple yes or no will not fully address the questions. If life exists, what is its distribution around the planet, its history, its relationship to the planet's geologic and climate history, and does it represent an independent origin from that on Earth? If life never existed, what is it about the Martian environment or its history that precluded its origin or existence?

Human Mars Missions Are Doable. The first human mission is not likely to be a full-up multi-year exploration of the surface. Such a mission would involve too many technical challenges and the stringing together of too many new developments. Rather, we can build toward that with a flyby or orbital mission using technology we have at hand today. This approach is analogous to the Apollo missions to the Moon – test out technologies in Earth orbit, then in lunar orbit, lunar flyby, full-up test in Earth orbit and lunar orbit, then land on the Moon. Taking this approach at Mars, we would start with a human flyby or orbital mission; we have the technical capability today to develop this mission. Taking this approach would allow us to start development today of a mission that could fly in 10-15 years, making it soon enough as to be real rather than infinitely far into the future. This mission also gives us time to develop the hardware for a later mission that would take people to the surface and back up, first for a quick sortie and then for a longer stay. A full-up program might take several decades to carry out fully, but would have short-term objectives that by themselves are important.

Human And Robotic Exploration Are Compatible: Many planetary scientists see the human exploration program as the enemy of "real" science. It's not an either/or – cancelling the human program, for example, would not result in that money going into the robotic program. Rather, the human and robotic programs are not only compatabile with each other, they are intimately intertwined – each plays on the successes of the other, and both work toward a common goal.

A decision to continue the human program or to send people to Mars will not be made on the basis of the science that will come out of it. That decision will be based on national pride, a desire to explore the unknown, and the challenge of doing human missions. If people are going to Mars, however, we should work to integrate science into these missions from the beginning. Robotic missions will inform the science to be carried out by human missions, can provide the context in which humans will explore, and can provide key information that will significantly help develop human missions have a higher level of robustness.

Science can be carried out by human missions, often in greater depth and more quickly than can be done robotically. While astronauts in orbit can target areas of the surface, control rovers more easily than from Earth, or explore Phobos or Deimos in person, the real value of having people there will be seen once they are on the surface – *in situ* exploration is dramatically enhanced when carried out directly by people.

Conclusions: We have the ability today to credibly plan and carry out a human mission to Mars. If Mars is the goal, we should do it by sending people to Mars and not by a decades-long diversion to somewhere else in the solar system. We have the capability to begin a Mars program today that has near-term, high-value objectives.