LEVERAGING THE STRENGTH OF COMPARATIVE PLANETARY GEOLOGY IN THE COMING DECADES. Paul K. Byrne1, 1Planetary Research Group, Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, NC 27695, USA (paul.byrne@ncsu.edu).

Introduction: In 1984, thirty three years before the Planetary Science Vision 2050 workshop, humans had yet to fly spacecraft by the ice giants and their moons, no rover had successfully explored Mars, half of Mercury remained unseen, and no asteroid, comet, or dwarf planet had been visited. Our knowledge of the Solar System, although substantial even in 1984, has increased markedly in the years hence. What new discoveries await us in the next thirty years?

A key tool for maximizing the scientific value of those discoveries is comparative planetology, by which the landforms, processes, and properties of other planetary bodies are assessed in the context of our understanding of similar phenomena on Earth. There has been no shortage of efforts to compare other worlds with Earth, or with each other, and numerous excellent compilations of these efforts exist for topics as diverse as planetary climate, ring systems, atmospheres, magnetospheres, interiors, and even habitability [e.g., 1–7]. Yet far more can be done to leverage the power of comparative planetology in the years to 2050.

Take geology, the field with which this author is more familiar: comparative planetary geology has been applied successfully in studies of the numerous Solar System bodies [e.g., 8–10]. Specific instances—of which there are a great many!—collectively define a wide range of topics that encompasses the assessment of extraterrestrial aeolian dunes with those on Earth [11], the characterization of how lacustrine and fluvial landforms on Titan parallel those on our own world [12], and the investigation of large-scale crustal shortening structures on Earth as analogues to tectonic landforms on other worlds [13].

Earth vs. Other Planetary Bodies: However, the field of planetary geology is small compared with the discipline of geology overall, the major focus of which is on Earth landforms and processes. (As a crude metric by which to illustrate this difference in size, Planetary Geology is but one of 18 Geological Society of America Divisions; at least eight other divisions overlap thematically with planetary geology. The European Geosciences Union is similarly structured: Planetary and Solar System Sciences is one of 22 divisions.)

Further, few students reading geology at post-secondary level are exposed much (if at all) to geological processes on other bodies. (The author writes from experience). As a result, students acquire a detailed training of the geology of a world with plate tectonics, even though that process is almost exclusive to Earth. Similarly, most solid-surface bodies in the Solar System are heavily cratered, many are dominantly volcanic in nature, and almost none interacts with a hydrosphere—so the geological processes and landforms to which most students are exposed are the exception, rather than the rule. On the other hand, the early histories of many Solar System bodies are recorded on their surfaces, providing insight into the conditions and processes likely present on the ancient Earth, for which little evidence now remains. As for any aspect of planetary science, then, the study of the geology of other worlds facilitates a better understanding of our own planet, and a thorough grounding of the geology of Earth allows for a more comprehensive view of our Solar System neighbors.

Opportunities: The pace of geological discoveries in this solar system is likely to increase even in the relative near-term [e.g., 14–16], and so there continues to be enormous scope for combining the expertise of researchers who focus on Earth-based geological topics with those who specialize in planetary geology.

Moreover, the greatest volume of new planetary science discoveries in the past couple of decades has come not from exploration of this solar system, but from astronomical characterization of extrasolar planets. Prior to the early 1990s we had no definitive evidence that planets existed in other star systems [17,18], but as of the time of submission of this abstract, 3,545 planets in 2,659 planetary systems are known [19]. With numerous missions currently working to characterize additional extrasolar planets, and yet more such missions planned [e.g., 20,21], it is likely that this field will continue to grow much faster than Solar System science in the next 33 years.

Finally, there exists the possibility—however remote—that extant or fossil life will be discovered on or within another planetary body in the next 33 years. Such a discovery would change planetary science fundamentally, with the biological sciences quickly playing a considerably larger role in planetary research than they do now, and planetary geology placing a greater focus on geobiology and paleontology.

A sustained and focused effort by planetary geologists to engage the global geological research community via thematic colloquia, interdisciplinary sessions at meetings, and topical special issues will foster comparative geological investigations. Working to integrate planetary geology topics into undergraduate (and even secondary and primary) education will ensure a steady supply of researchers cognizant of how our world resembles, and differs from, other Solar System bodies. These efforts will be augmented by partnering with the
astronomical and biological disciplines as fully as possible, to apply comparative planetary geology to our growing understanding of extrasolar worlds, and to rise to the incredible challenge of helping to characterize how, where, and when extraterrestrial life arose, should the need arise. And above all, it will be crucial to these efforts to encourage policy makers and funding agencies to support comparative planetary geology through existing and new interdisciplinary programs.

**Outlook for 2050:** It may be too lofty a goal to have dropped by 2050 the “planetary” in planetary geology, whereby the study and comparison of other bodies is as fundamental a part of the geological curriculum as petrology or stratigraphy—but the spirit of that goal should drive us over the next 33 years.

More broadly, we should continue to take every opportunity to more closely align planetary geology with the other disciplines that constitute planetary science, including (but by no means limited to) astronomy and biology. Advocacy for comparative planetary geology—and comparative planetology in general—must feature in the growth of our community going forward, for we will come to understand the workings of this and other solar systems most effectively only when we operate as more than the sum of our parts.

**References:**