REVISIONS TO THE ONLINE TEXTBOOK *EXPLORING THE PLANETS* (EXPLANET.INFO): MERCURY AND PLUTO. B.C. Spilker[1], E.H. Christiansen[1], and J. Radebaugh[1], [1]Brigham Young University, Department of Geological Sciences, Provo, UT 84602. braxtonspilker@gmail.com

Introduction: *Exploring the Planets* (http://explanet.info) [1] is a free online college textbook covering the basic concepts of planetary science, and the character and evolution of the planetary bodies in the Solar System (including the planets, important moons, asteroids, and Kuiper Belt Objects). The latest edition (3rd edition) was published online in 2007 by Eric H Christiansen. Earlier paper editions were published by Prentice Hall in 1990 and 1995.

Exploring the Planets approaches an introductory study of the solar system mainly through basic geological principles. Compared with other introductory planetary geology texts, such as *Planetary Sciences* by de Pater and Lissauer [2], *Introduction to Planetary Science* by Faure and Mensing [3], *The New Solar System* by Beatty, Petersen, and Chaikin [4] or *Earth, Evolution of a Habitable World* by Lunine [5], this is the only book with a basic geology approach. It is intended to be used as a primary or supplementary source in introductory science courses (geology or astronomy).

Book Structure: *Exploring the Planets* is divided into three sections. The first section gives a broad overview of the Solar System and an introduction to planetary science. This section helps the reader develop the geological background required to understand the processes that have shaped the planets, and to begin thinking like a planetary scientist. The second section discusses the planetary bodies within the inner Solar System (from Mercury to the asteroid belt). This section is organized by the size and complexity of the planetary bodies; beginning with the smallest and simplest (meteorites and asteroids) and progressing to the largest and most complex (Earth). The progression from simple to complex helps students to develop the ability to comprehend increasingly complex concepts. The third section discusses planetary bodies beyond the asteroid belt. Unlike the previous section, these chapters are organized by increasing distance from the Sun (starting with Jupiter and moving out to the Kuiper Belt). A final chapter on a comparison of the planets is included to further organize and complete an understanding of the planets and planetary processes.

A unique aspect of *Exploring the Planets* is its availability to the public. Many planetary science texts are only available as hard copies. Futhermore, these other texts are often written from a more advanced perspective, so the concepts may not be as consistently written in simple and easy to understand terms. *Exploring the Planets* helps surmount both of these problems.

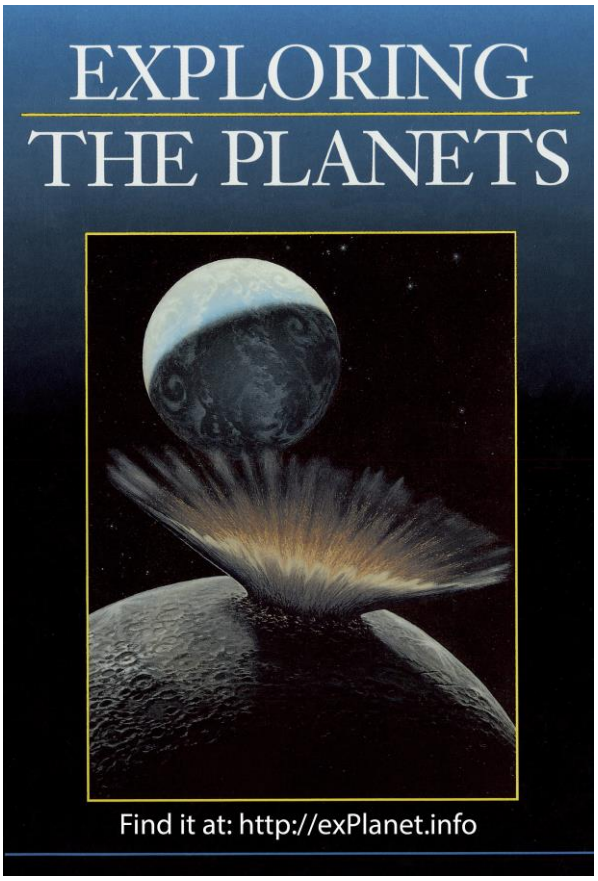

Figure 1. A new edition of the digital textbook *Exploring the Planets* is being prepared. It will will contain updated chapters on Mercury and Pluto. The *Orientale Impact* was painted by Teryl Bodily

Being online gives the public information about the solar system and helps educate college students who will use this resource. An online platform also makes it easier to update and keep current—no expensive and time-consuming effort to print the book on paper is required. A digital text also allows us to include or link to videos and animations that help bring life to the still images and static descriptions.

Problem: Since the release of the third edition, in 2007, of *Exploring the Planets*, two important planetary missions have been completed: *MESSENGER* (to Mercury) [6] and *New Horizons* (to Pluto) [7]. These missions provided new information and fundamental insights into these planetary bodies, which have not yet been included in *Exploring the Planets*. Other missions,

such as *Cassini*, have also yielded important new information about planetary bodies during this time frame, but we focus on Mercury and Pluto for this project.

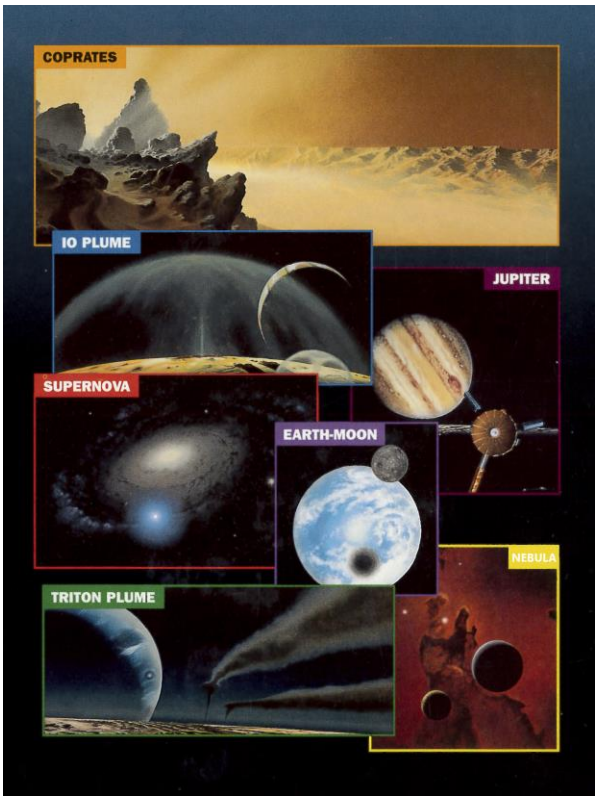

Figure 2. Illustrations for *Exploring the Planets* by Teryl Bodily

Significance: The modern results based on recent investigations of Mercury and Pluto are critical for our understanding of the nature and history of these bodies and the Solar System as a whole. These two planetary bodies are end members in a spectrum of objects in the Solar System. Mercury is small, hot, dense, and a silicate metal rich end member of the planets, helping scientists understand the thermal and accretionary evolution of the terrestrial planets. Pluto is cold, icy, distant from the Sun, and a representative object of the vast Kuiper Belt, and is thus another end member among planetary bodies. These two bodies refine models of how different planets evolved over time, and how our Solar System formed.

For these reasons, it is important to update *Exploring the Planets* to summarize the current understanding of the geology of Mercury and Pluto. This way, students can better understand their formation and evolution and the implications for the evolution of our Solar System.

Objectives: Our main objective is to produce two, pedagogically and scientifically sound chapters for *Exploring the Planets*, the first on Mercury and the second on Pluto. The finished chapters will be comprehensive in scope, accurate, and easy to understand, and will contain helpful figures and animations to facilitate learning. Instructors and students will be able to use this book as a resource in introductory college courses for non-science majors. The next edition of *Exploring the Planets* will be freely available at explanet.info. Anyone who desires to learn more about the planets of the Solar System will find this book helpful. This will also serve as an MS Thesis project for the lead author in Brigham Young University's Geological Sciences Program, which will illustrate the benefit of an outreach-based, scientific MS degree.

Methods: In to order to be able to produce instructive chapters on Mercury and Pluto, we are using effective pedagogical principles of transfer [8], cognitive learning [9], and cognitive apprenticeship [10] to organize, construct figures, and write text. We will implement these principles to help students recall previous information, present new information, guide students in developing critical thinking skills, and elicit and assess performance. The chapters will be evaluated by a MS Thesis committee made of the authors, plus additional external reviewers.

Conclusion: *Exploring the Planets* is a valuable textbook for explaining basic geological and planetary concepts to college students and so, it is important to keep the textbook updated. To provide a complete up-to-date and free resource on the planets, we are updating the chapters on Mercury and Pluto by summarizing the new scientific literature on these planets by rewriting the chapters and introducing new images/figures. We solicit your help as a reviewer or contributor.

References: [1] Christiansen E.H., and Spilker B.S. (2017) explanet.info [2] Pater I. and Lissauer J.J. (2010) Planetary Sciences. Cambridge University Press, United Kingdom [3] Faure, G. and Mensing T.M. (2007) Springer, Netherlands [4] Beatty, J.K. et al. (1999) Sky Publishing Corporation, Massachusetts [5] Lunine J.I. (2013) Cambridge University, United Kingdom [6] Solomon S.C. et al (2007) Science Science Reviews, 131, 3. [7] Russel C.T. (2008) Space Science Reviews, 140, 1. [8] Bransford J.D. et al (1999) National Academy of Sciences. [9] Hunt R.R. and Ellis H.C. (2004) McGraw Hill, Boston [10] Lave J. and Wegner E. (1991) Cambridge University Press, New York.