Preface

Earth is a very unusual planet and the Moon is a very unusual satellite. Our "twin sister" planet is also a very unusual planet. If Venus had a sizeable satellite in prograde orbit as Earth does, then life would be a bit simpler for the earth and planetary science community. Furthermore, if planet Venus had a transparent moderate density atmosphere, oceans of water, and continents with linear mountain belts, we would have far fewer questions about planet Venus. And if we could spot a few pyramids, whether trigonal, tetragonal, hexagonal, or octagonal, we would be very curious about the nature and history of the civilizations on our sister planet.

The characteristics of planet Venus, however, are much different than what we normally would predict for a "sister planet". The only attributes that Earth and Venus have in common are planetary mass, planetary density, and location at a similar distance from the Sun. So the main question of this book is: What happened to planet Earth to make it the **"paradise planet"** that we live on today? Or we can turn the question around and ask: "What happened to planet Venus to make it into the **"hades planet"** that it is today?

The purpose of this book is to present a scientific story for the development of the twin sister planets, Earth and Venus, that is consistent with our present knowledge of the Solar System and that is very testable by present and future earth and planetary scientists. This book has ten chapters of varying lengths and I think that it takes ten chapters to ask the questions and to tell the story. If only Earth, Venus, the Moon, and the Sun were involved, perhaps five chapters would be sufficient. But nearly the entire Solar System is involved in this scientific story of the twin sisters. Thus the narrative gets a bit lengthy and more complex than most of us would like to believe. This book represents something like the antithesis of the basic tenants of the test of Occam's Razor. A common statement of this test is that **"the simplest explanation for some phenomenon is more likely to be accurate than more complicated explanations."** I will admit that Occam's Razor works well for many problems in the world of science. But its usefulness in the earth sciences has some limitations. As a first example let us consider the Continental Drift/Plate Tectonics model. Although the model is simple in principle, it is very complex in detail and some 40 plus years after general acceptance, and a full century after conception of the idea, concerned scientists still cannot agree on when our modern style of plate

tectonics began. As a second example let us briefly consider the model of Milankovitch for explaining the ice ages on Earth. When I took a "Glacial and Pleistocene Geology" course in 1965, there were perhaps three pages on the idea in one of the best textbooks on the subject. The conclusion was that the model had failed many scientific tests and the implication was that the idea was not worthy of serious scientific consideration. Then by the middle 1970s, the Milankovitch Model emerged for serious consideration and is now a very useful paradigm in the earth sciences. Is it a simple model? NO! Is it easy to test? NO! Does this work with the Milankovitch Model support the basic tenents of the test of Occam's Razor?

How does the concept of Occam's Razor fit in with the story of the twin sister planets? I can state that the story of the twin sister planets is "simple in principle but somewhat complex in detail". In my opinion, the complexities, including the probability of a favorable outcome for certain processes, outweigh the simplicities.

A major theme of this book is that our twin sister planets had very similar physical and chemical characteristics soon after they were formed about 4.6 billion years ago. They formed in the same region of space and, according to the most recent work on planetary orbit resonances, they have been "shepherding" each other, as many twin sisters do, in a way to make their sun-centered orbits mutually stable. As a result the orbits of Venus and Earth are by far the most stable orbits in the inner part of the Solar System. Their life-long planetary partners (the planetoids that eventually become their satellites in this story) were accreted from material much closer to the Sun but also ended up in fairly stable sun-centered orbits. According to the most recent calculations their orbits were, in their first several 100 million years, the second most stable orbits in the inner Solar System. These planetoids, Luna and Adonis, eventually get perturbed out of their orbits of origin into a Venus-like orbit (for Adonis) and an Earth-like orbit (for Luna). They then get gravitationally captured by these large terrestrial planets and this is where the life histories of these planet-satellite pairs diverge. Venus captures Adonis into a **retrograde** orbit (that is, the planet is rotating in one direction and the satellite is orbiting in the opposite direction). Earth captures Luna in a **prograde** direction (that is, the planet is rotating in the same direction as the satellite is orbiting the planet). The remainder of the story is "planetary history". The end result is that the twin sisters are now "polar opposites" for habitability.

Chapter 1 is an introduction to the characteristics of the twin sister planets. Chapter 2 is a brief discourse on the early history of the Sun and how and why this early history is so important to the formation of Luna and Adonis, in particular, but really for all planets, planetoids, and asteroids out to at least the vicinity of planets Jupiter and Saturn. Chapter 3 is a brief treatment of intellectual endeavors associated with developing explanations for the origin of the Earth-Moon system. Chapter 4 is an explanation of my model of gravitational capture of planetoid Luna by planet Earth to form the Earth-Moon system. Chapter 5 consists of a series of "vignettes" (brief to the point stories) on various topics in the planetary sciences. The first three vignettes involve an analysis of the patterns of lunar maria and mascons (mass concentrations) that I think is crucial for developing a more meaningful interpretation of the features of the Moon than we have at present. Another vignette is on a

process for partially recycling a primitive crust inherited from a "cool early Earth" into the Earth's mantle by way of the very high amplitude rock tides caused by the process of gravitational capture. The final vignette in the chapter is on the subject of the origin of water on the twin sister planets, a somewhat neglected subject in the earth sciences but an important issue for our planet in particular. Chapter 6 is an explanation of my model for the retrograde capture of planetoid Adonis (a planetoid that is only one-half as massive as Luna) by Venus and the subsequent evolution of the system over time. A major feature of this model is that planet Venus has the possibility of being habitable for about 3 billion years before surface conditions deteriorate. Chapter 7 is a bit different in that it is more like "make believe" or "alternate reality" in that it presents a model for a retrograde capture of a lunar-mass satellite by Earth. The final result is an earth-like planet that has many of the features of planet Venus today: i.e., a "hades-like" scene, featuring a dense, corrosive atmosphere on a planet rotating slowly in the retrograde direction and with no satellite. In Chapter 8 some new concepts are introduced. The general theme of the chapter is that Planet Orbit—Lunar Orbit Resonances may be important for explaining some critical events in Earth History such as the beginning of the modern style of plate tectonics and the transition from a bacteria-algae based biological system to one featuring metazoan-type organisms. The main characters in the Planet Orbit—Lunar Orbit Resonances are "big brother" Jupiter for one resonance episode and "twin sister" Venus for three episodes. Chapters 9 and 10 pose some questions about how all these complex episodes in the historical development of Earth and Venus, and indeed in the history of the Solar System, relate to the habitability of our planet and for the possibility of finding other candidate planets for habitability.

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