LLS2024 Part 1 — Introduction & Basics

2-Introduction-Script.docx to accompany 2-Introduction&Basics.key

By Vincent S. Cronin, revised October 7, 2024

SLIDE 01 I want to thank Geary Schindell for inviting me to spend the day with you.

SLIDE 02 On the day I was born, humanity had not yet placed any object into Earth orbit. Earth had no artificial satellites until Sputnik 1 was launched eight and a half months later. We had never seen Earth as it is. This globe was pretty much how most of us viewed our planet.

Terms like "plate tectonics," "seafloor spreading," "transform fault," "oceanic fracture zone," and "subduction" had not been invented.

I think it is fair to say that, for most geoscientists of that time, "continental drift" — the idea that continents moved across the surface of Earth — was a fringe idea that seemed physically impossible.

SLIDE 03 Most geoscientists of that time would also say that human activities were altogether too puny to have any impact on global climate, although we were perfectly capable of producing smog that made it unpleasant to breathe in some big cities like the one where I was born -- Los Angeles. This is a view toward downtown Los Angeles from the hills behind my house on a smoggy afternoon in 2004.

SLIDE 04 Since I was born in early 1957, a combination of great mathematics, engineering, and science have allowed us to see our world much more clearly. This is the first photograph of Earth in its entirety, taken from space. On the fourth orbit of the Moon, Apollo 8 executed a change-of-orientation maneuver that brought Earth into view for the first time, and astronaut Bill Anders pointed the Hasselblad camera out the window to take this picture.

The contrast between the dynamic swirls of white and blue and green and brown of Earth with the desolate emptiness of Space and the apparently lifeless surface of the Moon could not have been more stark.

For the first time, we could see Earth as it is, in all of its great beauty. The experience was jarring in a way that I ***very clearly*** remember more than 56 years later. All of the cornerstone papers of early Plate Tectonics were published within a couple of years on either side of the day this photograph was taken.

SLIDE 05 This photograph was taken four years later by astronaut Ron Evans on December 7, 1972, about 18,300 miles from Earth on Apollo 17's journey to the Moon. By this time, the entire framework of first-generation plate tectonics had been published and featured in textbooks.

This is the first photograph of the entire disk of Earth, taken with the Sun behind and a wee bit to the photographer's left. It is said to be the most widely reproduced photograph in history and is called the "blue marble" photo.

What it shows (that a desktop globe cannot) is the flow of the atmosphere with all of its streams and eddies. Examined more closely, one can see the slower streams and eddies of the oceans that comprise nearly 70% of Earth's surface. The atmosphere and ocean are intimately connected to one another thermally, chemically, and physically in ways we are still working out.

The African continent displays its green band of photosynthetic life south of the Sahara, with its tans, reds, grays, and browns.

Just to the right of Africa are the Arabian Peninsula and Madagascar, which look like chips off the main continent.

This was a new world with secrets to be discovered.

SLIDE 06 My brother, Mike, and I grew up to be scientists of different sorts. He became a neurophysiologist and genetics researcher and had some of his experiments related to bone-density-maintenance flown on the shuttle Discovery during the STS41 mission in 1990. As an undergrad at Pomona College, I helped my advisor, Alex Baird, with the X-ray fluorescence experiment flown to Mars on the Viking II lander. That experiment involved collecting and analyzing the first compositional data for the Martian regolith. That was my first job in geoscience.

SLIDE 07 Science is the best process we have devised for understanding physical reality. It is based on reproducible observations, testable hypotheses, and the critical oversight of a community of truth seekers — of scientists and the public that they serve. The fundamental concept is that hypotheses that fail are set aside, and that allows us to progress toward a more reliable understanding of our world.

The scientific enterprise is a human endeavor and a community effort. We make mistakes, but we try not to. Each of us is individually good and bad, and above all else, fallible. The methods of science, pursued with ***integrity***, bend the ***arc of inquiry*** toward truth and understanding.

SLIDE 08 As we begin to think about a current version of plate tectonics, the first order of business is to think about what I mean when I refer to a first-order model. And, to some extent, what I mean by truth-seeking.

Consider the number pi. Pi is an irrational number, meaning it cannot be determined by taking the ratio of any two integers. The decimal part of an irrational number (that is, the part to the ***right*** of the decimal point) has an infinite number of decimal places, and no sets of decimal numbers repeat.

Pi is the ratio of the circumference of a circle and its diameter.

The value of pi with the first 57 decimals is pi = ~ 3.141592653589793238462643383279502884197169399375105820974...

<ad lib briefly>

SLIDE 09 Now, I want to think about the difference between a ***first-generation*** understanding or model and a ***current generation*** state of knowledge. On the left is the first commercially manufactured horseless carriage: Karl Benz's Motorwagen. It had an engine fueled with a petroleum product called ligroin. Aside from the novelty of it, nobody really wants to use this first-generation vehicle for routine transportation today. The current generation have electric motors that draw power from a big battery. Ours is charged using solar panels on our roof. It's safe, efficient, quiet, and can accelerate from 0 to 60 miles per hour in 6 seconds.

SLIDE 10 The web pages that I have created for this lecture series have some suggestions for accessible histories that I consider to be particularly good. They also have links to other resources related to today's lectures, so you can revisit ideas after we're done for the day. You are welcome to contact me and continue the conversation in the future.

In these lectures, I intend to remain firmly in the present. The history of how we got from our understanding of the Earth system in the late 1950s to our current understanding has been well told by others.

I want to build your understanding of some geoscience topics based on reliable, open-access datasets and other resources that are freely available. So let's get started learning about the basis of our current understanding of plate tectonics.