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**HIDDEN IN PLAIN SIGHT—Forward to Paul Remeika's *Ancient Lands: Discovering Anza Borrego's Geology***

It has been for me a glorious day, like giving to a blind man eyes. —he is overwhelmed with what he sees & cannot justly comprehend it. —Such are my feelings, & such may they remain.—Charles Darwin, following his first excursion in Cape Verde, in *The Beagle Diary* (1832)

Given the important role that Paul Remeika has played over the past 40 years in identifying the ages of Anza-Borregan fossils, volcanic ash beds, and sedimentary sequences, it seems appropriate to open “Hidden in Plain Sight”—my Forward to Remeika's *Ancient Lands*—by mentioning the precise date that I first encountered Remeika. This was a literary rather than a literal encounter, and it occurred on a Friday afternoon in February 1993 when I began reading Remeika's earlier, landmark study of Anza-Borrego's geology, *Geology of Anza-Borrego: Edge of Creation* (1992). At the time, my wife and I were spending a year-long sabbatical from our teaching duties at San Diego State University's English Department and were living at the Roadrunner Club in Borrego Springs. We had begun visiting Anza-Borrego Desert State Park in 1989, and over the next few years, Borrego Springs had become our constant getaway, a refuge from academic work and an escape from our high-energy social world of faculty parties, rock concerts, baseball games, and films.

During these early years, we sampled widely from the physical splendors of the Anza-Borrego Desert —the soaring mountains and jagged fault scarps, the end-of-the-world dismalness of the Salton Sea, the spectacular emptiness of the Borrego Badlands along the Salton Seaway (County Highway S-22) and State Highway 78, the even lonelier drives along S-2 in the southern part of the park, where we caught glimpses of the remnants of the Butterfield stage route and the edges of the Vallecito and Carrizo Badlands. But other than occasional hikes into Borrego-Palm Canyon and Hellhole Canyon, we had witnessed these sights mostly from the front seats of our Mustang convertible —but always on paved roads (this meant, for example, that we had never seen Font's Point or been in Split Mountain Gorge). Our experiences of Anza-Borrego was typical of most casual visitors and indeed of many full time residents —we marveled at the vistas and wildflowers, we took sightseeing drives, but most of our time was devoted to swimming, watching television, playing golf, and above all, reading (we were, after all, literature professors).

In other words, after four years of visiting we had grown to love Anza-Borrego —but our love was skin deep. Or to put it differently, we had developed a

“sunshine-and-lollipops” crush on something we barely knew, whereas the *real* object of our affections remained almost completely hidden in plain sight.

That all changed on that Friday afternoon in 1993, as I began reading *Edge of Creation*. Within just a few pages, I found myself feeling stunned, fascinated, amazed and seriously hooked by Remeika’s rare union of geology, paleontology and poetry in such vivid and dramatic passages as the following:

**“Across and around Anza-Borrego’s cactus-studded desert floor, spreads a landscape born of tectonic unrest. Massive earth fractures slash sharply drawn mountain ranges from arid valleys and basins. Major fault zones, thinning earth crustal slices, subsiding basins, upthrusting mountains, and on-shore seafloor spreading zones unite in a geologic performance played few places on earth, and no place else in North America.”** (*Edge of Creation*, p. 23).

Of course, at the time I couldn’t follow all the technical details involved in Remeika’s descriptions of Anza-Borrego –and, as is also true of this new study *Ancient Lands*, Remeika’s earlier *Edge of Creation* was above all a detailed, comprehensive, often highly technical description of the complex geology and paleontology of the Anza-Borrego Desert. But while at that point I admittedly couldn’t tell the difference between an anticline and a syncline, or between the Pliocene and the Pleistocene epochs, I could certainly recognize the broad outlines of the geological story that Remeika was telling about Anza-Borrego – and, as I’ve been suggesting, this story literally changed my life.



By late Sunday when I had finished reading, another important implication of *Edge of Creation* had dawned on me: not only was there an enormous, and enormously fascinating, physical landscape lying all around me that I had literally failed to see, but this was a landscape that could be explored BY ME! (◀) Even before leaving the next morning for my first “post-Remeika” drive around Borrego Valley, I had already begun to recognize that Anza-Borrego was literally inexhaustible – and that I wanted to spend the rest of my life exploring it.

And that’s exactly what happened –six months after reading *Edge of Creation*, my wife and I moved permanently to

Borrego Springs and began commuting to our day jobs at SDSU. And while I continued teaching until I retired in 2008, my real passion for these past three decades has been Anza-Borrego. And while I have now read dozens of geology books, and innumerable articles dealing with the specific aspects of this region, my most trusted guide in this quest has always been Paul Remeika.

### **REMEIKA: THE RIGHT MAN IN THE RIGHT PLACE**

To fully appreciate Paul Remeika's impact on the study of the geology and paleontology of Anza-Borrego during the course of his career, it is necessary to first have a rough sense of what assumptions and conclusions scientists were making about the area when he arrived as a patrol ranger in May, 1981. At that point, the picture most geologists and paleontologists had about Anza-Borrego was worse than "fuzzy;" in fact, it was more like an incomplete jigsaw puzzle with various pieces lying scattered across a kitchen table. Meanwhile, key bits of convincing field evidence that remained in plain sight had been totally ignored, while other crucial pieces didn't even seem to belong to the original picture! With myths and vague assumptions about Anza-Borrego's past festered into mainstream beliefs, nothing really made much sense.

Remeika arrived in Anza-Borrego on May 1, 1981 without a university position or a Ph.D. in geology; he was therefore not initially regarded as a "professional" geologist in the usual sense. But in the long run, this status as an "outsider" has proved to be one of the keys to Remeika's remarkable career, since it often forced him to arrive at his own conclusions based on field evidence he had personally seen rather than relying on the standard geological and paleontological paradigms—and prejudices—that his colleagues were using. For example, one much-in-vogue myth insisted that Anza-Borrego has always been a desert setting. This placed mammoths, mastodons, horses, camels, ground sloths, and other fur-bearing fossils that paleontologists had been collecting from deposits of the Pliocene and Pleistocene epochs—fossils that had made Anza-Borrego famous during the 1960s and 70s— as either questionable members of an arid megafauna, or as a megafauna whose bones had been transported to the region by the ancestral Colorado River. Two fortuitous discoveries that Remeika made soon after his arrival in Anza-Borrego not only indicated that he was a quick study but also illustrated his keen eye for recognizing anomalies in the field, his out-of-the-box thinking, and his undying willingness to pursue the implications of this field evidence, even when these conclusions contradicted those of the era's paradigm. The fact that he made both discoveries so quickly was obviously exhilarating, from a personal standpoint, but they also gave him the confidence and motivation that has shaped his entire subsequent career.

The first of these was his discovery, within just a week after his arrival, of the first fossil footprints ever found in the Colorado Desert while on patrol in the Vallecito Badlands that he would later name Camel Ridge. This soon led to



more than forty footprint sites in the Fish Creek Badlands that he would name as part of the Kraal, Carnivore Terrace, and Scavenger Ridge. The delicate time capsule track impressions left behind by ancestral river otter, cheetah, horse, camel, llama, and a larger gomphothere (to name just a few) represent a new unrecognized

fauna from the early Pliocene Epoch with no body fossil record to support them being here, and strongly indicated that the candidate trackmakers were indigenous, and flourished here as part of a natural cycle of life. This exciting field evidence opened up a whole new area of investigation for Remeika in vertebrate paleoichnology (i.e., the study of ancient traces left behind by animals) (see Remeika 2001, 2006a, 2011 in References and Suggested Reading at the back of this book).

Soon afterwards Remeika made a second discovery that was to prove even more ground breaking. As is frequently the case when scientific paradigms are about to be shattered, the item that eventually led to this revolution –a chunk of petrified wood that caught Remeika’s eye at a dig site in direct association with fossil camel bones north of Vallecito Creek- might not initially seem all that significant. In fact, when Remeika brought the sample to the attention of his colleagues at the dig site, they told him it was “just desert ironwood” and then threw it over the cliff of Badlands Ridge!

But while this sample was not deemed to be significant enough to be added into the study collections, something about it didn’t make sense to Remeika – the sample (and many others scattered throughout the Carrizo Badlands) did not resemble desert ironwood at all; but it *did* look remarkably similar to some of the petrified wood he had previously seen as a park ranger at Big Sur. Curious and puzzled, he retrieved the sample and after examining it more closely, sure enough, he was eventually able to determine that it was actually ancestral California bay-laurel (*umbellularia salicifolia*), the majority of which grew locally on the Colorado River delta during the early Pleistocene Epoch (see Remeika, et al., 1988). this discarded piece of wood opened up an exciting new chapter in his chosen vocation. After examining it more closely, he determined that it and many other pieces were actually ancestral California bay-laurel (*Umbellularia salicifolia*), the majority of which grew locally on the Colorado

River delta. Chunks of this wood had been lying around, ignored or misidentified by his colleagues, for decades. And while seemingly just a minor, insignificant piece of the Anza-Borrego puzzle, this tiny fragment turned out to be a key part of an *entirely different picture*, for it convinced Remeika beyond any shadow of a doubt that Anza-Borrego had once witnessed a maritime temperate environment, with dual influences off the Pacific Ocean and the Gulf of California during the Pliocene and most of the Pleistocene, prior to the recent and dynamic inception of a rain shadow desert. For Remeika this was truly a “Eureka!”



moment. The mountain ranges to the west had not reached their present heights—and thus the rain shadow that transformed the region into a desert had not yet occurred—until the middle Pleistocene (see Remeika 2006b, 2007). This discovery meant that Anza-Borrego is a young desert setting. Over the next decade, this key recognition gradually gained acceptance in the academic world.

A bit later, a third chapter in Remeika-ology awaited him at Mammoth Hill in the western Borrego Badlands, where colleagues were uncovering two large Columbian mammoths. Being young and enthusiastic, and possessing a strong back, Remeika was conscripted into operating a heavy jack-hammer at the site and the excavation soon turned into a passion for him. While thus engaged, he couldn't help but notice several light-colored horizons in the nearby deposits below and above the dig site. Being curious, he asked his companions about these peculiar strata, and was told they were nothing to get excited about—they were “just caliche beds” in keeping with a desert theme. But, once again, that answer didn't make any sense to Remeika. Upon further scrutiny (much, much further scrutiny, over several years), he discovered that both beds were airfall volcanic ashes, the lower later chemically fingerprinted as the Bishop ash bed—deposited 758,000 years ago from the Long Valley Caldera near Mammoth Lakes—and the upper bed, only a few feet higher than the mammoth dig, as being the ash of Thermal Canyon from the resurgent dome within the Long Valley Caldera, from 700,000 years ago. Once again, the correct calibration of

both ashes turned out to be another important myth-busting moment for Anza-Borrego, since it provided field evidence that led to a major re-evaluation on age control for the Borrego Badlands (see Remeika and Beske-Diehl, 1996; Remeika 2006). This re-evaluation, in turn, led to the true identities of the various fossils being discovered in the badlands. In particular, the animals that were originally thought to be very young in age (late Pleistocene) and named as such—since most of them occurred high in the stratigraphic section—turned out instead to be much older, belonging to the early and middle Pleistocene, due to their being bracketed by the ashes, or occurred below or above the ashes<sup>1</sup>. Nobody noticed the unconformity at the top of the cliff. Thus, the Mammoth Hill fossils turned out to be Imperial mammoths, a junior synonym of the Columbian mammoth.

Remeika draws upon his unsurpassed knowledge of local field evidence to address other myths concerning Anza-Borrego throughout *Ancient Lands*. Some of these myths conjure up a fantasy world so improbable and fantastic as to seem ridiculous. One of the claims deconstructed here is that the migration movements of mammoths from the Borrego Badlands and mastodons from the Carrizo Badlands were hindered by the presence of mountain ranges; but as Remeika demonstrates, today's mountains were not high enough back then, so that both animals easily co-existed in each sedimentary basin and later bone finds of each animal supports this determination.



twenty thousand years old. However, Remeika's discovery of the ash beds, which were laid down much earlier (750,000), proved that these fossil bones belonged to a much older species, the Imperial mammoths.

Remeika also refutes what is probably the most famous and persistent misconception about the area –the belief that during the Miocene Epoch a marine seaway from the Gulf of California flooded today’s Salton Basin, reaching as far north as Palm Springs. But Remeika notes that there is simply no valid field evidence to support this claim. Contrary to a plethora of traditional models, Remeika proposes a detailed restoration of marine deposits north of Palm Springs (located on the inboard, or western side of the San Andreas Fault), with similar deposits at the mouth of the Lower Colorado River Valley (located on the outboard, eastern side of the fault). This dramatically erases any hint that a Salton Basin existed here during the Miocene. Instead, both outcrops are shown to be physically offset, in a right-lateral sense, at least one hundred miles or more by fault dynamics that continue to wrench the basin apart. As he does throughout *Ancient Lands*, Remeika replaces a fuzzy mirage –that of a marine sea lapping the shores of Palm Springs- with a much more accurate picture of a Salton Basin residing *south* of today’s border with Mexico during the Miocene, with direct evidence that the Gulf of California’s northernmost waters filled in most of the Colorado River Valley north of Yuma up to Blythe, California and Parker, Arizona. He has seen these deposits first-hand.

#### **EDGE OF CREATION**

During the decade following his arrival in Anza-Borrego, Paul Remeika took advantage of his long, hot, mostly solitary daily drives as a patrol ranger to gain an unprecedented up-close-and-personal knowledge of the local field evidence. In effect, he transformed Anza-Borrego’s thousand-square miles into his own personal museum or geological laboratory. As his knowledge deepened and his confidence grew, he began to publish more of his own conclusions in a series of research papers that cast significant new light on the stratigraphy and paleontology exposed in the badlands of Anza-Borrego. In 1990, he helped initiate a new phase in the park’s paleontological development. Under his tenure, Anza-Borrego convened a Paleontology Advisory Board, formulated a paleontology collection management plan (see Remeika, 1991b), and a paleontology resource management plan. Always impatient with orthodoxy, he challenged conventional doctrine by mandating Anza-Borrego as an accredited repository, successfully recalled, loaded, and drove its 7,000-specimen vertebrate fossil collection from the Imperial Valley College Museum to Anza-Borrego’s visitor center, and was instrumental in recalling the State Park’s 5,900-specimen vertebrate collection from the Los Angeles Museum of Natural History. Throughout this period, he shared his discoveries by mentoring visiting geologists, voluntarily assisted many to achieve their doctorate degrees, and lead a series of legendary local field trips and popular desert hostels sponsored by the Anza-Borrego Foundation.

By 1992, Remeika—who in the meantime had been named curator of geology at the Imperial Valley College in Brawley and the first Park Paleontologist at Anza-Borrego, where he championed a state-sanctioned certificate training program in paleontology<sup>2</sup>—had poured much of his extensive research into his first book, *Edge of Creation*. Published by Sunbelt Publications and edited by Lowell Lindsay (who also wrote a forward for the volume), *Edge of Creation* was the first comprehensive, book-length description of Anza-Borrego's geology. While this landmark study contained a mix of old, handed-down concepts believed to be true at the time, it also offered new paradigms that contradicted the old, while providing a wealth of valid field evidence for its revolutionary conclusions. But as readers of *Ancient Lands* will soon learn, in many ways, *Edge of Creation* was just a warm-up...

### **DISCOVER ANZA-BORREGO'S GEOLOGY**

During the years following the publication of *Edge of Creation*, Remeika established the first interagency cooperative agreement between the State Park and the Bureau of Land Management for the long-term procurement, conservation, and management of paleontological resources on public lands designated as Federal Areas of Critical Environmental Concern throughout the western Salton Basin (see Remeika, 1995b). This led to the closure of several unofficial dirt roads that encroached into the Coyote Mountains. Under his dedicated stewardship, geologists and paleontologists have flocked to Anza-Borrego in increasing numbers. But no other figure has made as many important new discoveries and other contributions to our growing understanding of this enormous, bewildering complex region as Remeika. Over the next two decades, he continued to publish a series of major articles—over fifty in all—that have had a major impact on the interpretation of Anza-Borrego's geology and paleontology. These papers collectively reveal Remeika's widening interests and his growing expertise in several new cutting edge methods and topics. Among these are several that readers will find synthesized in various ways throughout *Ancient Lands*, including:

**a).** the identification of vertebrate footprints, primarily from the Carrizo Badlands and the Borrego Badlands<sup>3</sup>; in several instances these footprints represent a new fauna based solely on track impressions; **b).** the use of

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<sup>2</sup> Remeika presented a paper on these fossil footprints at the National Park Service Fossil Resource Conference at Grand Junction, Colorado in 2001.

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magnetostratigraphy and tephrochronology<sup>4</sup> to provide chemical analyses of the Bishop and Thermal Canyon ashes<sup>5</sup>—processes that, as I discussed earlier, organize the first reliable interdisciplinary age controls for the western Borrego Badlands; **c).** locating and identifying a series of open and closed freshwater tufa shoreline depositions; these investigations provided evidence of ancient lakes that once existed in Borrego Valley and Clark Dry Lake, as well as older shoreline evidence along Font’s Point Wash and at Font’s Point, Inspiration Wash, Ella Wash, and several other locations; **d).** the identification of ostracodes (tiny arthropods), vertebrates and locally-derived petrified woods (a younger, new paleoflora yet to be described) that provide age-diagnostics and living dynamics for the environments in which they were deposited prior to the rain shadow; **e).** recognition of rock formations as sequences following conventional priority of nomenclature rather than naming and renaming them over and over again in the literature which has always confused the picture; and **f).** discovery of vertebrate fossils in the Mecca Formation east of the Salton Sea, a ground-breaking find of marine Pleistocene fossils in the Brawley Formation outcropping in the Superstition Hills, and on and on....

Nearly two decades in the making and representing the culmination of Remeika’s entire career, *Ancient Lands* is a landmark work that will almost certainly become the standard textbook for specialists in geology and paleontology for many years to come. Moreover, Remeika has also made this new study as “reader friendly” as possible for non-specialists. Thus, geologic terms are simply defined in the glossary at the back of the book, and a bunch of suggested reading references are listed following the glossary, too. And as was also true of *Edge of Creation*, this easy-to-follow *Ancient Lands* primer uses road and hiking logs to organize his discussions, thus offering interested readers the opportunity to visit the sites he describes and examine the field evidence for themselves.

**“THE SIGNIFICANCE IS NOT WHAT YOU DISCOVERED, BUT WHAT YOU TRULY LEARNED ABOUT THE DISCOVERY”**

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<sup>4</sup> Remeika provides a full description of these methods in *Ancient Lands*, but basically magnetostratigraphy is a technique used to date sedimentary and volcanic sequences by analyzing the remnant magnetization (i.e., the polarity of Earth’s magnetic field) at the time the stratum was deposited; tephrochronology is a technique that analyses discrete layers of tephra –volcanic ash from a single eruption- to create a chronological framework in which paleoenvironmental (as well as archeological) results can be placed.

<sup>5</sup> Remeika’s 1992 discovery of the Bishop ash bed within sediments in the western Borrego Badlands was unquestionably one of the most significant geological discoveries ever made in Anza-Borrego.



For the past 40 years, Paul Remeika has lived a life in which almost every free day took him on a journey millions of years back in time. Through old-fashioned grunt work of scientific field study, spending days-on-end hiking and camping across the magnificent desolation of the Borrego and Carrizo sedimentary basins, Remeika has gradually refined his understanding of prior landscapes and their ancient records of events and faunas. *Ancient Lands*, serves as a much needed necessity, filling a void between desert enthusiasts and earth science *aficionados* interested in learning more about the geologic history of the state park, and the scientific community which is often reluctant to accept anything that is hard for them to dispute. So far, Remeika succeeds in fitting the pieces of this fascinating, enormously complex puzzle into a “real time” picture far more accurate than the fuzzy mirage he encountered when he first arrived here, thus making Anza-Borrego ultimately vastly more interesting and intriguing.