

Eocene and Oligocene Paleosols of Central Oregon, Gregory J. Retallack, Erick A. Bestland, and Theodore J. Fremd (Editors), 2000. Geological Society of America Special Paper 344, Boulder, 196 p. (Paperback \$58.00) ISBN: 0-8137-2344-2.

In the past 20 years, paleopedology (the study of paleosols, or ancient soil horizons) has become one of the hottest areas of research in sedimentary geology. A number of geologists have added paleopedology to their repertoire of skills, and many important discoveries have emerged from the study of paleosols. One of the scientists who sped up this process in the United States was Greg Retallack of the University of Oregon. Beginning with his pioneering studies of Eocene-Oligocene paleosols of the White River Group in the Big Badlands of South Dakota (published in 1983 as *GSA Special Paper* 193, and summarized in his 1990 book *Soils of the Past*), Retallack has made many important discoveries using ancient soils.

GSA Special Paper 344 presents the results of many years of research by Retallack, his former student Erick Bestland, and John Day Fossil Beds park paleontologist Ted Fremd. Focusing on the spectacular color-banded buttes and cliffs of the Eocene-Oligocene Clarno and John Day Formations of central Oregon, they have uncovered a fascinating climatic history that parallels the results Retallack obtained in the Big Badlands 18 years ago. The lowest beds of the middle Eocene Clarno Formation indicate a subtropical climate with high rainfall and dense forest vegetation, comparable to that of modern southern Mexico. Through the upper Eocene and lower Oligocene beds of the Clarno and John Day Formations, Retallack et al. document a progressive drying and cooling trend in the soils and their inferred vegetation; hence, the middle Oligocene deposits suggest a drier, grassy woodland landscape. This is closely comparable to the trends observed in the Eocene-Oligocene transition throughout the world (Berggren and Prothero, 1992; Prothero, 1994a, 1994b; Prothero and Emry, 1996). Clearly, the Clarno-John Day sequence is connected closely to the global trends in climate observed elsewhere.

The bulk of the monograph is a detailed description of all the different types of paleosols encountered in the study, complete with designation of type sections, chemical analyses, as well as a description of the floral and faunal data recovered from each paleosol. Such descriptions and analyses are critical to documenting a detailed study such as this, and seldom permitted the space they require in a conventional journal article. The illustrations of these paleosols is excellent, especially the exquisite hand-drawn landscape reconstructions by Retallack which have become the best visual reference for what these ancient Eocene and Oligocene landscapes once looked like. Included in these detailed descriptions are 12 appendices occupying almost 40 pages, a necessary use of space that would never be possible except in a monograph format. As he has before, Retallack has chosen to label each paleosol type with its own distinctive local name, rather than try to shoehorn each paleosol into pre-existing categories. Some paleopedologists might quibble with this practice, which is analogous to typological splitting, and emphasizes local variation at the expense of broader synthesis. Certainly, the local names (derived from the local Native American Sahaptin tongue) are harder to remember, and definitely more difficult to pronounce. Try "Pswa", "Cmuk", "Xaxus", "Sitaxs" or "Kskus" on your tongue! It would have been nice if the authors had provided some sort of aid for pronunciation for those of us not familiar with Sahaptin.

There are, however, some controversial points that not all geologists would agree with. The stratigraphic interpretation of the Clarno sequence, especially the famous "Nut Beds" flora, has long been difficult to interpret. Hanson (1996) interpreted this sequence in an entirely different fashion, placing the "Nut Beds" much higher in the Clarno Formation. Retallack et al. (p. 3) discuss their interpretation of the stratigraphy and their reasons for differing with Hanson (1996). Given the complications of this problem, and the adequate space to present it in a monograph such as this, I would have liked to have seen more detailed documentation, outcrop photos, and diagrams to support their interpretation. Likewise, they prefer to accept radiometric dates on the lower Clarno Formation in the 43 Ma range, and not the dates in the 48 Ma range accepted by Hanson (1996), and consistent with the Bridgerian fauna recovered from that level. They suggest (p. 6) that there might be some controversy as to whether the Bridgerian/Uintan boundary could indeed be as young as 43 Ma, but numerous radiometric dates cited in Prothero and Emry (1996), plus direct ties to the marine microfossil sequence in the San Diego area, prohibit this. Thus, one must take the bottom calibration point of their sequence with a grain of salt, because it is contradicted by a lot of recent evidence, and inconsistent with the emerging consensus about the Bridgerian and Uintan land mammal "ages" in the Rocky Mountain region.

Despite these problems, however, the overall methods and conclusions of this research are well founded, and yield only the second clear

example of such a detailed paleoclimatic sequence in North America (the first being the Big Badlands). In fact, this sequence is even longer and more complete, spanning the interval from 28 Ma to at least 44 Ma with no major breaks, while the Big Badlands sequence only spanned the interval from 38 to 28 Ma with several significant unconformities. Since long, detailed sedimentary records of climatic change spanning this much time are rare on any continent, such studies are extremely valuable not only in providing a demonstration of local climatic change, but also allowing contrasts across the continent to be evaluated, and differences between the local and global signal to be assessed. It will be interesting in the future if similar long paleosol sequences could be found on other continents to corroborate or contrast with the trends now documented from two loci in North America.

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Palaios 16(4):420-421

(2001)