



Introducing a Cartographic Masterpiece: A Review of the U.S. Geological Survey's Digital Terrain Map of the United States, by Gail Thelin and Richard Pike
Author(s): Peirce Lewis
Source: *Annals of the Association of American Geographers*, Vol. 82, No. 2 (Jun., 1992), pp. 289-300
Published by: Taylor & Francis, Ltd. on behalf of the Association of American Geographers
Stable URL: http://www.jstor.org/stable/2563898
Accessed: 28/02/2014 10:34

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at http://www.jstor.org/page/info/about/policies/terms.jsp

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



Taylor & Francis, Ltd. and *Association of American Geographers* are collaborating with JSTOR to digitize, preserve and extend access to *Annals of the Association of American Geographers.*

http://www.jstor.org

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions

Map Reviews

Introducing a Cartographic Masterpiece: A Review of the U.S. Geological Survey's Digital Terrain Map of the United States, by Gail Thelin and Richard Pike

Peirce Lewis

Department of Geography, The Pennsylvania State University, University Park, PA 16802,
FAX 814/863-7943

LET us not mince words. The United States Geological Survey has produced a cartographic masterpiece: a relief map of the coterminous United States (Fig. 1) which, in accuracy, elegance, and drama, is the most stunning thing since Erwin Raisz published his classic "Map of the Landforms of the United States" in 1940.[1]

To be more precise about it, a group of geologists and cartographers at the Survey's office in Menlo Park, California, led by Gail P. Thelin and Richard J. Pike, have produced what they call "a digital shaded-relief portrayal . . . of the landforms of the coterminous United States." In plain English, it is a relief map that looks like someone took a photograph of the lower forty-eight states from a spacecraft on a perfectly clear day, under nearly perfect lighting conditions, with an almost perfect camera.

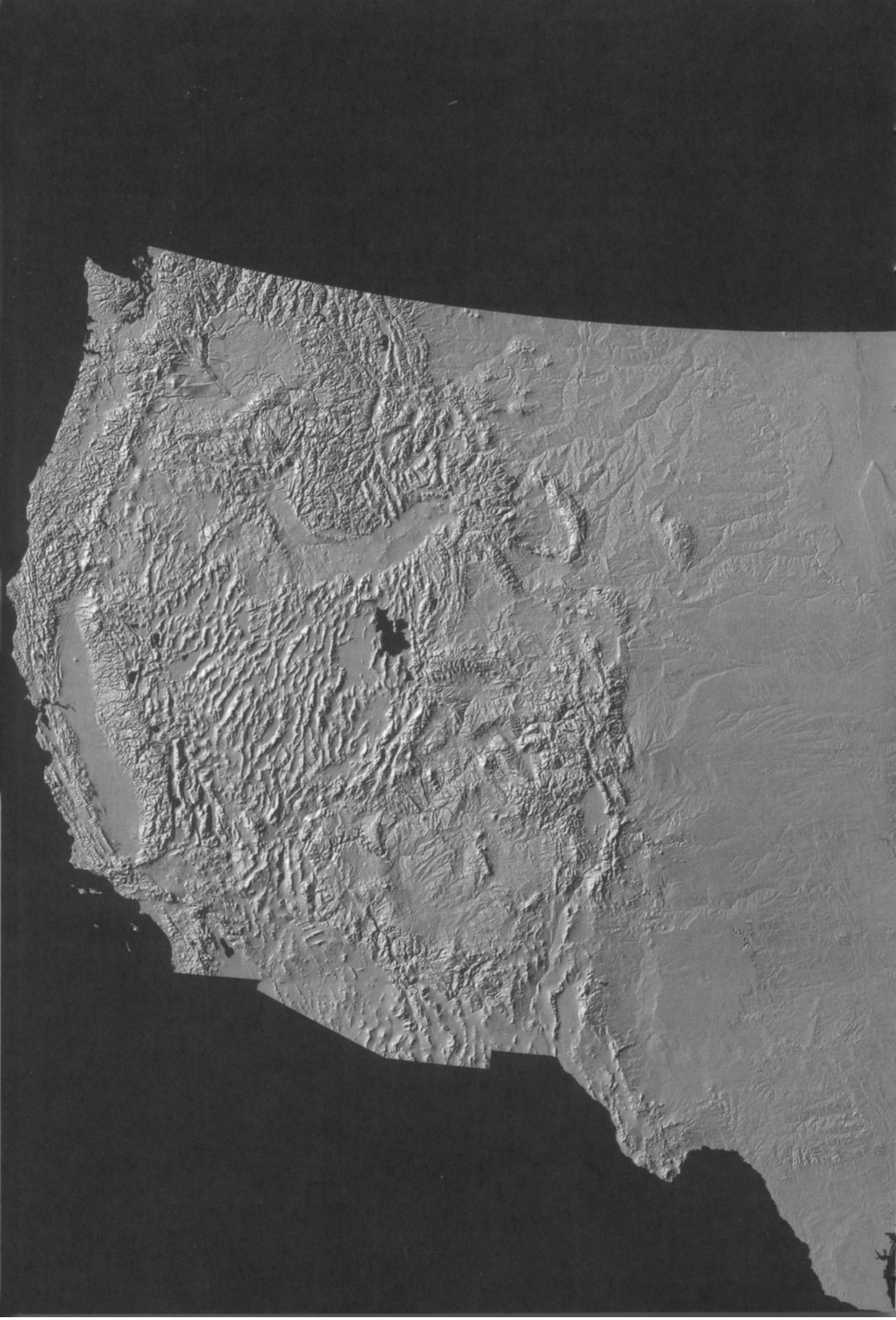
This is not the place to discuss the map's technical properties (see Thelin and Pike 1991; Pike and Thelin 1990–91; and Pike's essay in this volume). The user of the map should understand, however, that the map was generated by computer and based on a grid of 12 million spot-elevations, spaced less than a kilometer apart. Given the size of the U.S., this is a very fine-grained database, and produces an image of such detail that minor Appalachian ridges in Pennsylvania can easily be identified by name. The result is a map that depicts the U.S. in grand panorama, but simultaneously in exquisite jewel-like detail. It is, consequently, a map which any enthusiastic amateur can appreciate for its panoramic beauty, but is also a treasure trove of detailed information for the professional geographer. It is, quite simply, a wonderful map, and an indispensable document for any serious student of the U.S.

To viewers familiar with American landforms, the map is both reassuring and surprising: we know the patterns, but are surprised at how clearly they stand out, and how much more we see than with most conventional maps. A cross-section from the New Jersey shore to the Kentucky Bluegrass (Fig. 2A) is revealing. (See also, for comparison with Raisz's map, Fig. 2b; and for a modified, color version, Fig. 3.) We see a Coastal Plain that is far from featureless, a subtle but familiar Fall Line (clear in the north, but becoming tattered south from Virginia), the rolling Piedmont with its Triassic inliers, the shredded remnants of the Blue Ridge, the Great Ordovician Valley, the familiar but always remarkable Ridge-and-Valley country, the Appalachian Plateau with its warped eastern

Editor's Note: Because the recent publication of new landform and land surface maps represents cartographic innovations and has use in research and instruction, I commissioned a review and also asked the authors to describe their products.

Annals of the Association of American Geographers, 82(2), 1992, pp. 289–304
© Copyright 1992 by Association of American Geographers

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions



This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions



Figure 1. Digital shaded-relief image of the conterminous U.S. (reduced from 1:3,500,000 scale). U.S. Geological Survey map I-2206 (Thelin and Pike 1991).

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions

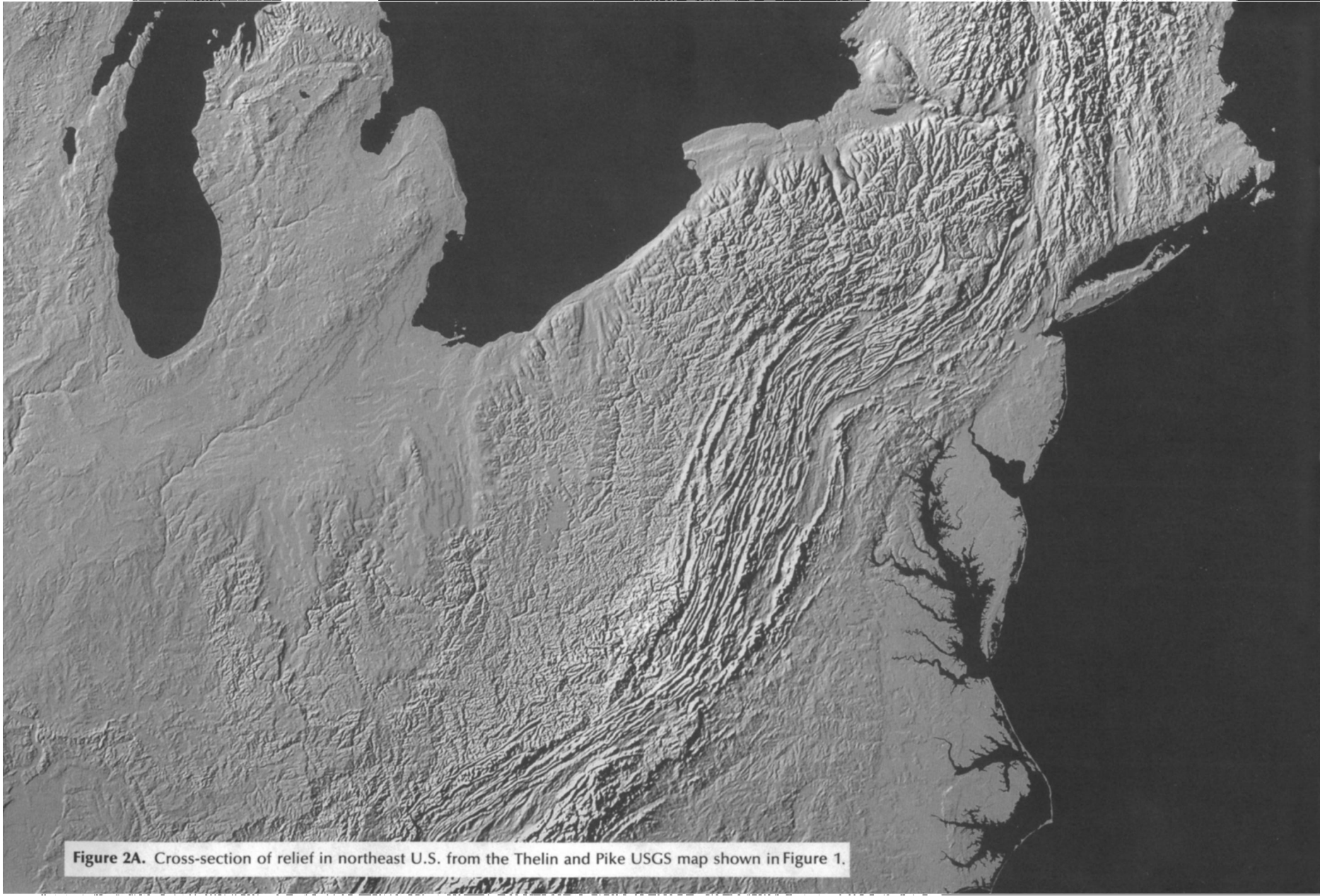


Figure 2A. Cross-section of relief in northeast U.S. from the Thelin and Pike USGS map shown in Figure 1.

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions

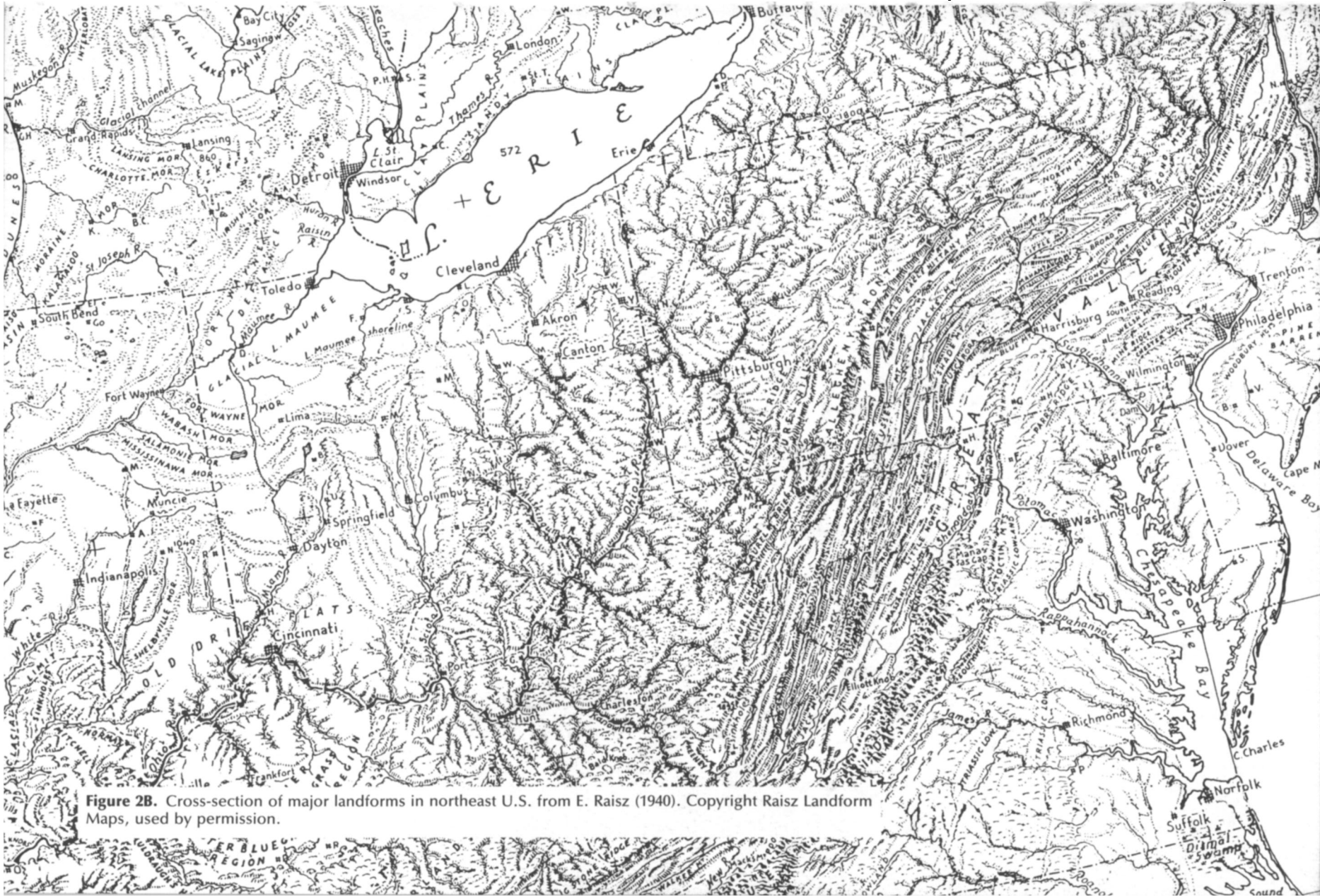
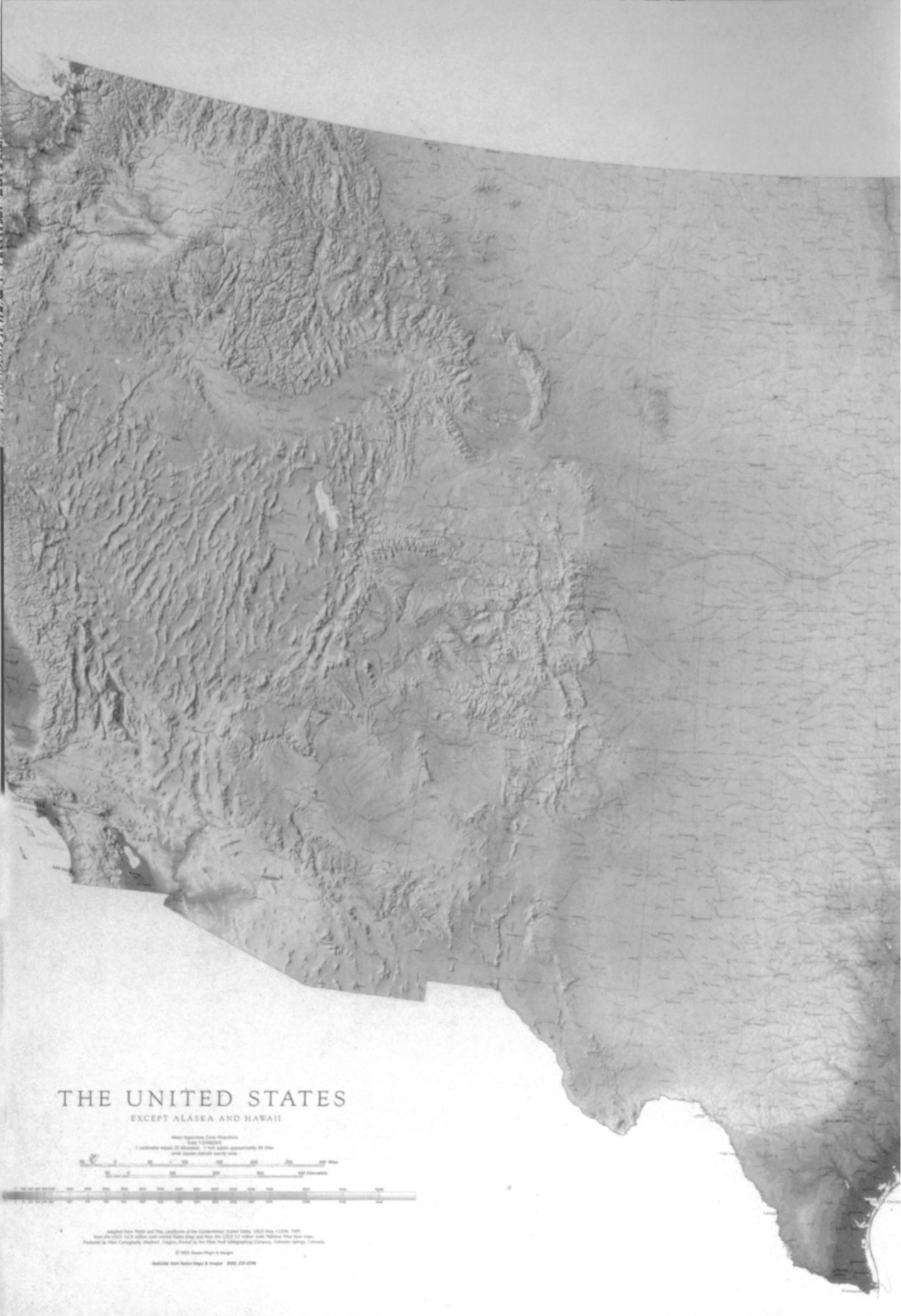


Figure 2B. Cross-section of major landforms in northeast U.S. from E. Raisz (1940). Copyright Raisz Landform Maps, used by permission.

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions



This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions



Figure 3. Hypsometric tinting of the U.S. digital relief image map showing elevations, physical features, and selected cultural features. Source: Stuart Allan, Raven Maps and Images, 1992; used by permission.

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions

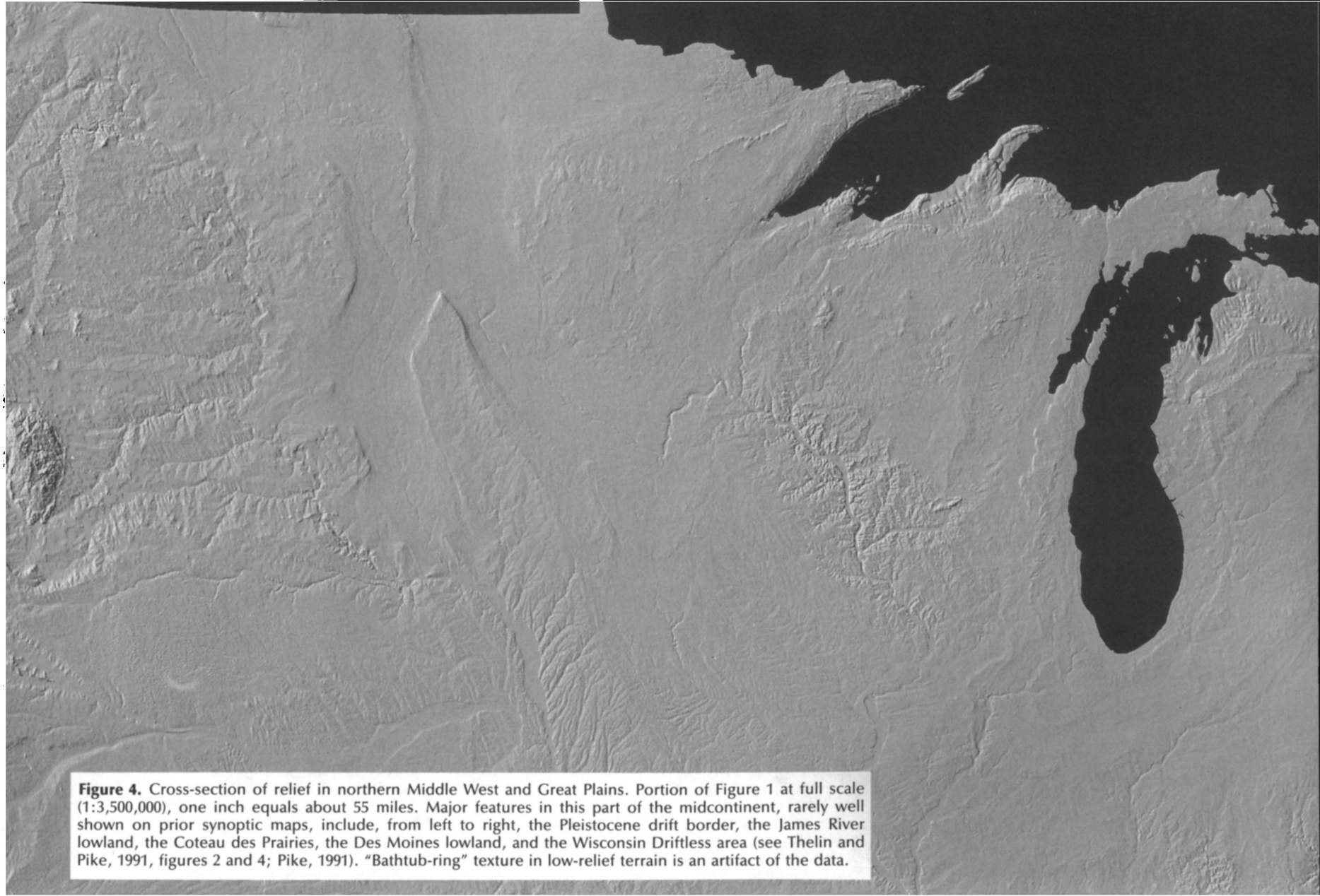


Figure 4. Cross-section of relief in northern Middle West and Great Plains. Portion of Figure 1 at full scale (1:3,500,000), one inch equals about 55 miles. Major features in this part of the midcontinent, rarely well shown on prior synoptic maps, include, from left to right, the Pleistocene drift border, the James River lowland, the Coteau des Prairies, the Des Moines lowland, and the Wisconsin Driftless area (see Thelin and Pike, 1991, figures 2 and 4; Pike, 1991). "Bathtub-ring" texture in low-relief terrain is an artifact of the data.

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions

edges, the maturely dissected dendritic terrain where the Plateau merges into the Interior Low Plateaus and Central Lowlands.

Farther inland, the map reminds us that there is no such thing as a boring landscape—and, if nothing else, proves that the Midwest is by no means the boring plain depicted in *New Yorker* cartoons. The mark of Pleistocene ice is almost everywhere, and it is plain that the ice did different things in different places (Fig. 4). The High Plains in the northern part of Michigan's Lower Peninsula are revealed as a wedge-shaped upland, carved on its southeast by the ice of the Saginaw Bay lobe and on the northwest by the Lake Michigan lobe. The Missouri Coteau is a similar ice-carved wedge, its surface finely fluted by postglacial fluvial erosion, and flanked by gargantuan ice-carved swaths, later swept by proglacial meltwater. Between them, the characteristic stream-carved topography of the Driftless Area is easily recognized, as are the great spillways that carried off the last of the glacial meltwater: the Wabash, the Illinois, the Wisconsin, the Minnesota, and (of course) the Mississippi itself. On a global scale, such things are delicate and fragile features—the Coteau and myriad subtler features are sometimes hard to recognize from the ground. But there is no doubt about their presence when seen on the new relief map.

The West, as expected, is a treasury of delights. The map reveals the remarkable internal geometry of the great crystalline intrusions, etched here like intricate mosaics: the Idaho Batholith, the Sierra Nevada, the Uintas, the majestic swaths of the High Plains of Kansas, Oklahoma, and Texas, the volcano-pimpled arc of the Snake River Plain (not so planar, it turns out), the dramatic flat lake-beds of Lahontan and Bonneville, the nearly flat surface of California's Central Valley, its expanse broken dramatically by the Marysville Buttes. One can imagine spending minutes or hours or days or a lifetime discovering the wonders of the map, and the country it depicts. It is that kind of map.

As an official publication of the United States government, the Thelin-Pike map resides in the public domain, and carries no copyright. It is so handsome and gratifying, however, that it is fair game for copying or modification by corporate cartographers, who may sell their products for profit to the general public. Indeed, that has already happened, and we may count ourselves fortunate that the first major private printing of the map comes from the Raven Press, of Medford, Oregon—a small mapmaking enterprise with a well-earned reputation for making spectacular and beautifully-printed wall maps.[2]

Raven, in fact, has published two versions of the USGS map. One, in black and white, looks very much like the original (it was printed from negatives made by the USGS). It is, in some ways, an improvement. Raven has added a fine-grained network of rivers and lakes, which makes the USGS map easier to use—by the average user who simply wants to locate things, but also by geomorphologists, to whom patterns of drainage are crucially important elements of the natural landscape. The black lines, although artfully drawn, tend to obscure the shape of individual river valleys. Thus, the Wisconsin and upper Mississippi Valleys are easily recognized as flat-floored glacial spillways on the Thelin-Pike map, but not so easily on the Raven map. Raven has also added a large variety of place names. In clumsy hands, labels could have ruined the USGS map, but Raven's cartographers are both discreet and skillful. One can find the labels if one wishes, or one can equally well ignore them.

The Raven map also differs from Thelin-Pike in the degree of contrast. At first glance, that difference would seem trivial, but it is not. Thelin and Pike chose to create a map of sufficient contrast to reveal subtle midcontinental features like the Wisconsin Driftless Area and the Missouri Coteau. In high-relief areas of the Cordilleran West, however, that level of contrast turns steep terrain opaquely black, and much Cordilleran detail is lost thereby. Raven reclaims that detail by using less contrast, but loses a certain level of midcontinental detail in consequence. Flatlanders and orophiles will look at the two maps differently.

Raven's second version of the Thelin-Pike map is a spectacular multi-colored hypsometric map, plainly meant to stun the reader with its sheer chromatic opulence (Fig. 3). Paradoxically, while the map is spectacular, it is very traditional in design, in lettering and in choice of colors: lowlands are green, high elevations are off-white, and intervening elevations are yellow, brown, and beige. But the impact of the whole map is dazzling and elegant—in the same way that a fine antique oriental rug can

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions

be dazzling, as a display of traditional virtuosity. Scholars will find it hard to use because the colors tend to blur the wealth of detail that make the USGS map so wonderfully appealing to geomorphologists. But Raven's hypsometric map was obviously not designed for the use of professional geomorphologists. It was meant to be hung on a wall and admired, and it serves that purpose with elegance and grace.

There is one other major difference between Raven's privately printed maps and the Thelin-Pike map from the Geological Survey. Raven's maps cost $35 each ($60 laminated); the USGS sells the Thelin-Pike map for $5. This is not the place to argue the merits of private versus public use of government data and publications, although that argument sorely needs to be aired. The reason for the difference is obvious enough: the very considerable expense of programming and printing the Thelin-Pike map was absorbed by the general budget of the USGS. Raven must pay the non-inconsequential costs of production from profits from sales. Five dollars is not much for a map of this quality, but American taxpayers can take solace that their tax dollars are at work, paying for something useful. Besides, the overhead has long since been paid, and then some. But if enthusiastic cartophiles want to buy a shaded relief map of the U.S. for five dollars, they would be well-advised to get their order in soon. The USGS has a lamentable habit of underestimating demand, and many of their best publications are now out of print.[3]

Inevitably, there will be invidious comparisons with Erwin Raisz's "Landforms." What many aficionados simply call "The Raisz Map" was originally published to accompany Wallace Atwood's *Physiographic Provinces of North America* (1940). Atwood's book is long out of print, outdated by later and better treatments of American regional geomorphology (see especially Thornbury 1967; Hunt 1967; and Schimer 1972). But the Raisz map survived to go on and on, through a sixth edition in 1957, just before Professor Raisz's death.[4] Happily, it remains in print today, for sale at a very low price, wonderfully accessible to the general public.[5]

I have long been fond of telling students that Raisz's landform map is the best map of the U.S. that I know of, irrespective of subject. No matter how one sets about to judge the map—as cartography, as art, or as a vivid and accurate rendition of the American land—the map is incomparable. I have traveled with it for more than thirty years; indeed, to travel by air in the U.S. without Raisz is (to me) unthinkable. I have worn out countless copies in automobiles and railroad cars and airplanes. I have given it as a free-will offering to friends, academic colleagues in every imaginable discipline, airplane seatmates, pilots, and beloved nephews. I have used it as a required text in classes for almost the same length of time, lecturing from it, arguing from it, loving it, proselytizing its virtues. I regularly receive postcards from students in unlikely corners of the U.S., joyfully reporting that they went to a certain place because it looked interesting on Raisz—*and it was—just like Raisz drew it!* I can only guess at the number of professional geographers who were first seduced into the field by acquaintance with the U.S. by way of Erwin Raisz.[6]

So which is better? Raisz or the new Thelin-Pike map?

That question, it seems to me, is not very useful. In many ways, the new USGS map is more like an aerial photograph (or sideward-looking radar image) than it is a map. Like a camera, it records what it "sees" without discrimination—beyond what the computer programmer told it to see. The Raisz map, on the other hand is indisputably a map. Raisz made all kinds of highly idiosyncratic decisions about what to record, and how to record it. That he did so with artistry, elegance, and with a good deal of geomorphic knowledge is our good fortune. But Raisz shows us particularly important things to look for. (See, for example, the way he renders the Allegheny Front in Pennsylvania.) And he left a good deal off the map (look for example, at the economy of line in his rendering of the Llano Estacado), and, correspondingly, he puts things on—which no photographer or computer programmer could or would have done. It is not just a matter of labels and names; as Raven has demonstrated, the Thelin-Pike map can be published with place names overlaid on it. But there is no doubt on Raisz's map that the Llano Estacado is not flat, but instead slopes eastward with mathematical regularity. (Raisz has provided a judicious number of spot elevations, in case we are in doubt.) From the Raisz map, we are forced to conclude that the Llano is part of a great apron of alluvial

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions

debris swept from the Southern Rocky Mountains, and later truncated on the west by headward erosion by the Pecos River, and creating (among other things) the Mescalero Escarpment.

So it is not a question of whether the USGS's new terrain model or the Raisz map is "better" than the other. Both are superb, and they complement each other beautifully. The two inevitably will be used side by side, and each gains much from the pairing, as so often our understanding of an aerial photograph is enriched by comparison with a high-quality topographic map of the same area. And there is no need to stop there. The USGS's wonderful "Tectonic Map of the United States," used with both Raisz and the USGS terrain model, yields genetic insights about American landforms which any of the three alone only hint at.[7] By adding a geologic map, the mix grows yet headier. There is no end to such a process of cartographic multiplication, nor is there any need for one. The wealth of ideas to be gained is simply endless.

There is another use for the new USGS map, and it may be the best of all. It is an ideal gift for someone you care for intellectually—a bright aspiring young geographer, an intellectually curious parent or aunt or uncle. I can think of few gifts more handsome, or that would speak more eloquently of one's intellectual respect for the recipient.

The remaining task, of course, is for Thelin, Pike, and their associates at the USGS to map the rest of the world the same way. I can hardly wait.

Notes

1. The USGS map is available across the counter from the Geological Survey at the very low price of $5.00. It can be ordered as USGS Map I-2206 from the USGS, Denver, Colorado, or Reston, Virginia.
2. The map can be ordered from Raven Map Images, 34 North Central Street, Medford, OR 97501, or by calling 1-800-237-0798. In paper, the map sells for $35, or $60 laminated.
3. This practice is (or should be) a national scandal. The United States of America is one of the few large countries in the world which has allowed its national atlas to go out of print and apparently has no plans to create a new one. Indeed, until very recently, one could not even buy a desk-sized *geologic* map of the U.S. from the USGS; all the copies had long since been sold. I hazard a prediction that the same thing is likely to happen to the Thelin-Pike map, despite its wonderfully high quality and despite what is sure to be a continued demand for it. *Caveat emptor!*
4. Atwood's book also included Raisz's incomparable geologic structure-sections across various parts of the U.S.—masterpices in their own right, just as good as the map itself. John Schimer (1972) rescued and republished many of them for which we must all be grateful.
5. Geographers owe a debt of gratitude to the Raisz family for keeping the map in print, and generously allowing academics to reprint portions of it for little or no royalties. The map can now be purchased for about two dollars from Erwin Raisz Landform Maps, P.O. Box 2254, Jamaica Plain, MA 02130. It has always seemed to me a pity that the Raisz map is not generally available at mass-market bookstores across the country; it remains the best *sub rosa* buy in the highly uneven world of American map publishing.
6. In a way, I was. I first learned about the Raisz map from Stanley Dodge at the University of Michigan, and it was through Dodge and Raisz that I first began to understand the profound difference between map reading and map interpretation. I was reintroduced to it by J. Hoover Mackin at the University of Washington, who used the Raisz map with evangelical zeal and deadly effectiveness. Dodge and Mackin were two of the best teachers I have ever had, and Erwin Raisz was a third.
7. The "Tectonic Map of the United States" is another superb USGS publication, and it comes at two scales, both very useful. The smaller one at 1:7,000,000 was originally published in the *National Atlas of the United States*. A wonderfully detailed large-scale version comes in two large sheets at a much larger scale.

References

Atwood, Wallace W. 1940. *Physiographic Provinces of North America*. Boston: Ginn and Co.

Hunt, Charles B. 1967. *Physiography of the United States*. San Francisco: W. H. Freeman.

Pike, Richard J., and Thelin, Gail P. 1990–91. Mapping the nation's physiography by computer. *Cartographic Perspectives* 8 (Winter): 15–24.

Raisz, Erwin. 1956. (Map of the) Landforms of the United States, 6th ed. Jamaica Plain, MA: Erwin Raisz Landform Maps.

Schimer, John A. 1972. *Field guide to landforms in the United States*. New York: MacMillan.

Thelin, Gail P., and Pike, Richard J. 1991. Landforms of the coterminous United States—a digital shaded-relief portrayal. Essay to accompany Map 1-2206. Washington: U.S. Geological Survey.

Thornbury, William D. 1965. *Regional geomor-*

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions

phology of the United States. New York: John Wiley & Sons.

U.S. Geological Survey. 1962. Tectonic map of the United States exclusive of Alaska and Hawaii. Washington.

Visualizing the United States in Computer Chiaroscuro

Richard J. Pike* and Gail P. Thelin**

U.S. Geological Survey, *345 Middlefield Road, Menlo Park, CA 94025,

FAX 415/329-4936.

**2800 Cottage Way, Sacramento, CA 95825

THE modern computer has imparted new power and meaning to the old axiom "One picture is worth a thousand words" (Davies et al. 1990). Machine visualization—the art, science, and technology of seeing via computer graphics—has developed the means to view the unviewable: natural events and processes invisible to the unaided eye because they are too abstract, complex, fast, remote, small, or large (Friedhoff and Benzon 1991). Earth's topography is an apt example of the last restriction. Customary methods for viewing the landscape do not simultaneously provide broad coverage and accurate detail. The Earth's surface cannot be seen at 1:1 scale in its entirety and all at once, but just in many small areas visited sequentially in the field—clearly too great a task even over the lifetime of an individual. Spatial continuity and context can only be obtained at greatly reduced scales: on contour maps and aerial photographs, on radar images, or at even smaller scales on satellite images.

Computer graphics overcomes these problems and offers a fresh look at the Earth's landform patterns by mechanizing an old approach: relief representation (Brassel et al. 1974). The well-known technique of shading, or chiaroscuro, developed by Renaissance painters, shows topographic form by intensity of the Sun's shadows (Imhof 1965). Because manual (artistic) methods can economically portray only small areas both accurately and in detail, Yoeli (1967) adapted a quantitative variant of the technique, termed analytical hill-shading, for digital execution. Large areas have been mapped by mechanized shading, but until recently spatial resolution has remained low (e.g., Moore and Simpson 1982). Our digital relief map of the entire conterminous US (Fig. 1), which shows features as small as a mile across, is one of the first images to combine detail with synoptic coverage (for a Swedish example, see Elvhage and Lidmar-Bergström 1987).

The machine-shaded maps shown here resemble cloudless aerial photographs, but actually are large arrays of minute gray rectangles (nominally squares). Each rectangle, or picture element (pixel), represents a reflectance (brightness) value of the topography computed from a mathematical expression called the photometric function. This equation, which has many variants, relates (1) ground slope and azimuth, (2) location of the observer (here, overhead), and (3) position of a simulated Sun (here, from the west-northwest at 25° above the horizon) (Yoeli 1967; Batson et al. 1975). Light and dark tones on the resulting image show steep areas; intermediate tones are gentle terrain. The data from which the maps are created are dense square-grid matrices of terrain

This content downloaded from 128.148.231.12 on Fri, 28 Feb 2014 10:34:59 AM
All use subject to JSTOR Terms and Conditions