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Cataloging Planetospatial Data in Digital Form: Old Wine, New Bottles—New Wine, Old Bottles

This discussion deals with using traditional library cataloging methods–e.g., Anglo-American Cataloguing Rules (AACR), USMARC—to catalog planetospatial data in digital form and the problem areas that have come to light.

INTRODUCTION

University research libraries are in some ways like modern medicine, most noticeably in their tendency toward specialization. For example, an ear-eye-nose-and-throat doctor may not be the person you would like to trust to take care of an ailment that happens south of the larynx. Similarly, in the approximately twenty years to 1988 that I have been occupied with (among other occupations) cataloging maps, I never once cataloged digital data (but I have an excuse—no digital data in the library with the exception of the online catalog) (distant sound of the gods laughing).

At the same time, it was obvious, even ten years ago, to many in map librarianship that our portion of Library Land was going digital. Thus the last five or so years have presented many learning experiences, especially since Project Alexandria started in October 1994. Project Alexandria—or, as it is also called, the Alexandria Digital Library—is one of six National Science Foundation-funded Digital Library Initiatives (DLI). Alexandria's goal is to provide online access to georeferenced information starting with planetospatial data. My role in Alexandria is multipartite, focusing on metadata, data set selection (both metadata and spatial data), and general information on library services and practices—what works, what does not, and what services we would like to provide to users. Very specifically, since early October of 1994, I have had primary responsibility for working with a computer engineer to design a metadata schema (called the Alexandria Metadata Schema). This metadata schema is a brief version, with several simplifications (e.g., no punctuation between fields) of USMARC, with special emphasis on the fields of the U.S. Federal Geographic Data Committee's Content Standards for Digital Geospatial Metadata. Mike Domaratz, a main architect of the later standard and another presenter at this clinic, will provide specific comments about that. Other than some allusions that reflect the work done for

Alexandria over the last several months, what is presented in this discussion is a snapshot of a work in progress as I decide how to deal with the moving target of digital data forms. Honesty compels me to admit that the Alexandria Metadata set is composed of a paltry 130 records, only about half of which are digital data (although all of the analog items have been scanned).

It is from this experience whence comes the subtitle 245$b. "Old wine, new bottles" in the title of this presentation refers to information formerly presented in paper, and other generally eye-readable, versions now being presented in digital form—initially in somewhat literal transformations but increasingly in new ways. The "new wine, old bottles" refers to the tremendous fun we have fitting new formats into old cataloging rules, adding or changing the latter as new data to be accessed appears or as existing types develop new wrinkles. As for the adjective "planetospatial," the rationale follows that the term "map" is obviously inadequate. How about the term "spatial data"? That encompasses too much since it includes measurement of any object in space (e.g., medical imaging). The terms "geospatial data" and "georeferenced information," however, each begin with a word derived from the root "ge-", that is, Earth, so data relating to other planets would not be covered. "Cartographic materials" comes close, but to many people it means maps only. For example, there is a feeling that the MARC Map format is to be used only for maps, which is not correct—it may be used (at least in theory) for any cartographic material. "Georeferenced information/data" does indeed nicely cover anything that can be given a latitude/longitude reference—"spatial data that pertain to a location on the Earth's surface" (Farrell, 1994, p. 1). Thus it includes, for example, gazetteers, population statistics, histories of countries, and so on. So that seems to leave us with "planetospatial data," a term suggested by a computer science graduate student.

The two learning experiences that are the basis of this presentation are those of my self-education in cataloging digital planetospatial data, and of explaining Map and Imagery Lab materials and library cataloging practices to computer science (and other science) faculty members and graduate students. The latter has been occasionally—but fortunately, seldom so—an embarrassing process, since once I looked into something—and sometimes even after a quick glance—I found practices that were difficult or impossible to defend. In some cases, these practices seem to be based on the problem on which library science has been based—as the name indicates—on a format (the book) instead of on a concept (information). It has also been my observation, as I read various manuals on cataloging digital data, that there are differing ideas and perhaps some confusion as to how to catalog that data.

On the other hand, there have been moments of sweet revenge, as when a few months into putting together a prototype, a computer engineer informed me, in tones of amazement and indignation, that compiling metadata was extremely time consuming. You will be pleased to know—maybe—that the efforts we have made to ensure that users do not have an inkling as to what goes on before an item is ready for use have succeeded beyond our wildest expectations. I have also learned that much of what we take for granted in online cataloging—e.g., having all fields, whether repeatable or nonrepeatable, on one form; having as many full-text (as compared to varchar/limited-to-256-characters fields as are needed); having the computer software "know" that, for example, Calif. = California = CA is no mean code-writing/database-management-software feat.

It has been most helpful to read the writings of people in other disciplines turning their minds and their discipline's habit of thought to cataloging (see especially Bretherton and Singley [1994] to see how a model of catalog access to information looks to two atmospheric scientists). It is ironic that information derived by cataloging had to be called something else—metadata—before noncatalogers dealt with it. This is similar to persons who claimed they could not type who, all of the sudden, learned how to type when computers came in, and the name of the work was described as "inputting." The bright side of dealing with metadata for digitally generated data is the promise (which one fervently hopes will not evanesce) that software (perhaps the tools of spatial databases and analysis) may be used to extract metadata. It cannot happen too soon for me.

It seems inevitable, in this self-education process, that there are some areas where cataloging GIS and other planetospatial digital data has meant the need for some retooling and reworking—and perhaps some reinvention—of existing cataloging policies and procedures. It is extremely fortunate that the purpose of cataloging policies and practice is to ensure that users will be able to get at the data in ways that they consider the most logical. This means that catalogers using jesuitical reasoning to get the access points needed is perfectly acceptable. Yet, overall, much of what exists in current cataloging practice works quite well. The following text will reveal exceptions to this premise. As part of the work-in-progress aspect of this discussion, it will be obvious that there are no answers for all of these concerns, although there are routes of attack.

But first let us take a glance backward. In the "The more things change, the more they remain the same" category, Dodd's (1982) remarks as to why machine-readable data files may be difficult to catalog:

1. currently lack desirable standards in bibliographic representation; AACR2 (Anglo-American Cataloguing Rules, 2d ed.) does not adequately define bibliographic elements as they apply to MRDF;
2. lack of internal user labels: poor documentation, lack of such traditionally used elements as a title page although a standard for a header does exist (ANSI X3.27);

3. production rather than publication is the rule;
4. data are easily and, in some cases, often changed, so assigning editions may be difficult;
5. dates of publication may be problematic because of 3 and 4 above; and
6. physical description is a problem area, since the items are so different from traditional library materials (pp. 35-37).

Thus the following list of the problem areas I have seen will come as little surprise:

1. physical description, especially 300$a generally and specifically SMDs but also 300$b and the way this field relates to file-characteristics area (256) and mathematical data (255);
2. production versus publication;
3. merging another standard—Content Standards for Digital Geospatial Metadata with USMARC;
4. multilevel description;
5. looking in a mirror looking at self holding a mirror—when one catalogs an analog item (e.g., a map), which is scanned at high resolution and when does one stop cataloging? Does one catalog the scanned file separately?
6. subject headings;
7. bounding coordinates; and
8. time—which one?

PHYSICAL DESCRIPTION

General Material Designations (GMDs), Specific Material Designations (SMDs), and (not surprisingly) the USMARC formats are a mixture of intellectual and physical formats, of content and form, of information and carriers of information, and of frequency. It is tempting to say that they were heuristically developed in order to deal with existing data, that they work, that format integration enables one to use any field needed, and to leave it at that. The fact remains that putting, for example, "map" in the same category as "slide" is not logical.

General Material Designations (GMDs) in AACR2 include

List 1—braille, cartographic material, computer file, graphic, manuscript, microform, motion picture, multimedia, music, object, sound recording, text, videorecording.

List 2—art original, art reproduction, braille, chart, computer file, diorama, filmstrip, flash card, game, globe, kit, manuscript, map, microform, microscope slide, model, motion picture, music, picture, realia, slide, sound recording, technical drawing, text, toy, transparency, videorecording (Gorman & Winkler, 1988, p. 21).

USMARC formats include: book, serial, archives and manuscript control, machine-readable data files, maps, music, visual materials.

Specific Material Designations (SMDs) include: monographs in book form: no SMDs referred to as such—v., p., leaves, columns, broadside, sheet, portfolio (p. 72).

Serials designations include: Use the relevant specific material designation (taken from subrule .5B in the chapter...) e.g., wall charts, filmstrips versus microfiches (p. 288).

Cartographic materials include: atlas, diagram, globe, map, map section, profile, relief model, remote-sensing image, view (p. 108).

Manuscripts: not referred to as such except in other physical details (300$b); same as book format, plus: items, ft. (ca. items OR v. OR boxes) (pp. 130-31).

Music materials: score, condensed score, close score, miniature score, piano [violin, etc.] conductor part, vocal score, piano score, chorus score, part (p. 150).

Sound recordings: sound cartridge, sound cassette, sound disc, sound tape reel, sound track film (p. 170).

Motion pictures and videorecordings: film cartridge, film cassette, film loop, film reel, videocartridge, videocassette, videodisc, videoreel (p. 190).

Graphic materials: art original, art print, art reproduction, chart, filmslip, filmstrip, flash card, flip chart, photograph, picture, postcard, poster, radiograph, slide, stereograph, study print, technical drawing, transparency, wall chart (p. 209).

Computer files: computer cartridge, computer cassette, computer disk, computer reel [add new one SMDs as new physical carriers are developed] (p. 231).

Three-dimensional artefacts and realia: art original, art reproduction, braille, cassette, diorama, exhibit, game, microscope slide, mock-up, model.

If none of these terms is appropriate, give the specific name of the item...as concisely as possible—e.g., "hand puppet; jigsaw puzzle" (pp. 250-51).

Microforms: aperture card, microfiche, microfilm, microopaque.

Add cartridge, cassette, or reel, as appropriate...add cassette, if appropriate, to microfiche (p. 266).

MARC Formats: Book, Serial, AMC, MRDF, Maps, Music, Visual Materials. Separate out carriers of information—e.g., microform, digital—from rest.

The heart of the problem seems to be that any item falls into several different classifications simultaneously and orthogonally—a good time to remind ourselves that classification is just a way for human beings to think logically about the universe, which is a continuum. Following—in no particular order—are the major types of classification that a cataloger may have in mind:

a.	manuscript	printed
b.	monograph	serial
c.	analog	digital
d.	text	graphics
e.	moving	still
f.	codex	single-sheet
g.	eye-readable	not eye-readable
h.	sound	no sound
i.	ascii	binary
j.	actual object (3-D)	representation of an object (generally 2-D)

Lack of consistency—brought about, one suspects, mainly because the codex has predominated as a method of transporting information for much of the history of libraries—becomes obvious when one cruises through AACR2R seeking out 300$a.

For nonatlas, nondigital monographs and serials: pp. or v. [carrier; general assumption that item is in one volume unless otherwise stated].

For cartographic materials: 1 map/view/section/diagram ["on 1 sheet" is assumed], 1 globe ["on 1 sphere" is assumed], 1 model (ambiguous—what kind of model?), 1 atlas (pagination), 1 diagram [on 1 sheet] (ambiguous—what kind of diagram?), 1 view [on 1 sheet], 1 section.

For digital data: we are firmly in carrier-land—"9.5.B1. When new physical carriers ...." appear, formulate terms—computer cartridge, computer cassette, computer disk, computer reel, computer laser optical disc (why is it that everywhere except in catalog records are these called CD-ROMs? Do most users even know what "computer laser optical disc" means?).

Going back to AACR2 for the sake of comparison, we are dealing with what seem more like intellectual forms: i.e., data file, program file, object programs. For contrast, the map curator of the Royal Library, National Library of the Netherlands, includes in physical descriptions the number of floppies, files, and bytes as appropriate (J. Smits, personal communication, 16 December 1993).

This whole problem is especially noticeable when one, for example, has a serial CD-ROM of AVHRR data (Advanced Very High Resolution Radiometer)—it qualifies simultaneously as serial, machine-readable data file, graphic (and so on), and map (since the data are generally displayed on a computer screen as a map); so, which SMD (or collection thereof) are you going to use? What takes precedence? Information type or carrier type? And why not be consistent throughout AACR (e.g., "____ intellectual item/substantive form of material on ____ physical form") or isn't it possible?

This brings us to the subject of file characteristics. This field is in the same family as 255, Mathematical data (scale; projection; coordinates).[1] In AACR2R (it did not exist in AACR2), file characteristics are given as:

Computer data (_____ files, _____ records, _____ bytes)
Computer program (as above)
Computer data and program (as above).

It would seem more appropriate for this field to include, in addition to whether the material is data or software, such matters as whether it is text or graphics or both or whether data can be displayed in color (more about this later). Bytes are analogous to words or possibly to number of pages and therefore seem more appropriately placed in physical description (specifically in 300$a); also, geospatial data sets are often large (e.g., a black and white 9" x 9" air photo scanned at 600dpi requires 29 megabytes, a color photo requires 91 megabytes, all bands of a SPOT image could require approximately 400 megabytes), and it makes sense to give these in megabytes rather than in bytes. Files are like chapters. What is the point of having this information? Most importantly, users have little or no interest in the number of chapters in a book, and I have about as much interest in counting files as I do in counting chapters or plates. And what does "record" mean? It is not in the glossary of AACR2R. As indicated, these seem more appropriately located in physical description than in file characteristics.

Reverting to physical description, for 300$a, how about an amalgam of AACR2 and AACR2R: computer data on CD-ROMs or 580 megabytes on 1 computer laser optical disc or 10 images (580 megabytes) on 1 CD-ROM? But this will not work for GIS databases, where the number of maps that might be constructed is infinite. As always, everything depends upon the author's or publisher's intent.

Moving on to other physical details, 300$b, we have: 1 computer laser optical disc : col. Although the intent is to indicate that the data on the disc will display in color, what is actually being said is that the disc itself is colored. Even the description: 580 megabytes on 1 computer laser optical disc : col. is not much better because of the way whether or not data may be displayed in color is carried:

10 images (580 megabytes) : col. is accurate. Bytes are not in color in the way that a map is in color. In raster data, each pixel is associated

with a value from 0 to 255, which denotes what grey-scale value that pixel has. The image may be displayed either as grey-scale (black and white) or as color depending on the software in use.

Yet another point. In the version of guidelines for cataloging Internet resources that I have, it is stated that one does not use 300 because there is not a physical item to describe. It would be more accurate to say that one does not have a physical carrier to describe. If one considers number of bytes (which definitely do take up space as anyone who has watched the memory in a pc go to 2 percent empty knows) to be analogous to pages, then 300$a is an appropriate place for size of file.

PRODUCTION VERSUS PUBLICATION

If publication is defined as distribution of multiple copies by sale or by other transfer, then digital data seems to qualify. In the 1993 *Guidelines for Description of Internet Resources* (Patton, 1993), it is noted that, generally speaking, only electronic serials are considered published, but if a monographic item carries a formal statement similar to that found on the title page of a monograph, then it may be considered published (p. 1). Practically speaking, any file that is made available for others to use—whether through anonymous FTP site or Mosaic—is, in digital terms, published.

University faculty members are presently dealing with this "is-it-published" conundrum in the sort of way that wonderfully fixes one's attention—is work made available over the Internet considered to be a publication that will "count" toward getting tenure?

MERGING TWO STANDARDS

Metadata in Project Alexandria must be compatible with two metadata standards, USMARC and the Content Standards for Digital Geospatial Metadata. USMARC is a database format; it is not a cataloging-rules standard—that standard is AACR. One step yet further away are the cataloging concepts upon which AACR is based. This may explain some of the problems I have seen in applying Content Standard for Digital Geospatial Meta Data, since making equivalencies between something that is a concepts standard (Content Standards for Digital Geospatial Metadata) and something that is a database-format standard (MARC) is obviously going to run into difficulties. At a more abstract level, the two standards are different. Both are concerned with accurately and briefly describing the item in hand, but the Content Standards for Digital Geospatial Metadata is intended mainly for use by data producers, while USMARC is mainly for agencies that make information available but generally do not produce it.

Another point is that USMARC has evolved since the late 1960s from cataloging policies and practice that date back 100 years and more, while the Content Standards for Digital Geospatial Metadata was put together in just a few years under the gun of a Presidential Executive Order stating that all federal agencies had to document their geospatial data using a standard that the Content Standards for Digital Geospatial Metadata would produce. These different beginnings engender different attitudes and result in documents that are different.

The much longer time frame in which current cataloging practice in libraries has had a chance to evolve has the additional benefit of allowing that practice to have a sturdy base of supporting standards, e.g., the USMARC: database format; ISBD; LCSH, and by extension; BGN place names; USGS lexicon of stratigraphic names; LC's schedules for classification; LC NAF; Z39.50; specifically for cartographic materials, AACCCM; and so on.

MULTILEVEL DESCRIPTION/PARENT-CHILD RELATIONSHIP

AACR proposes but LC disposes. In AACR2, multilevel description became an option for catalogers, including those who recognized users' needs for planetospatial data at the sheet or frame level—a problem, given that standard cataloging is at the series or flight level. For example, it is rare that people need to see every sheet of Morocco at 1:100,000, yet that is the only level at which the series appears in standard cataloging. It was only when USMARC finally had a linking field–772—hat libraries were able to put this into practice. There is no note relating a child to a parent—the link is solely in the vertical relationship tag and is carried as a number. Mainly, it seems to have been applied in the AMC format although the then National Map Collection of Canada has used it (Parker, 1990). The Canadians also used two local-interest fields which unfortunately have no USMARC equivalents:

UTLAS field 1083
Local-interest code:
  001 parent record
  002 subrecord
  003 both parent and subrecord
UTLAS field U035
UTLAS local information code: 1 parent record
  2 analytic $a accession no. (Parker, 1990, p. 89)

Possibly 008/25 (Cartographic material type), which is confined to: single map, map series, map serial, globe might be expanded to include the categories given as 002 and 003 in UTLAS field 1083, since map series is, in effect, 001 (although such a series could also be a subrecord). The general rule is that what is common to all children is recorded at the first level. Each successive level contains only the information pertinent to that level and does not repeat what is at a preceding level. There are several different layers, all of which, mercifully, are not needed in all cases for various forms of planetospatial data:

a. air-photo flight:
   Flight   Flight Line   Roll   Frame
b. satellite imagery:
   Overall mission name   Satellite number   Scene ID
c. map series:
   Parent   Another parent   Subseries   Child
d. GIS:
   i. Parent   Tile (geographic areas adjoining each other; analogous to topographic map sheets in a series)
   ii. Parent   Various themes/layers/coverages

There is rarely much common metadata among coverages since each generally has different lineage. It would also be difficult to devise a concept that survives from one GIS software to another. It will be interesting to see how this system works when one applies it to digital data and specifically to vector data.

It can happen that a child can belong to more than one series—i.e., it can have more than one parent. This is the sort of occurrence that causes database-software engineers to go grey before their time. In addition, it will work best from a database point of view if child records have different fields than do parent records, but that is not possible. For example, both parent and child records will have title fields, call number, and a few other fields in common. This was indicated by a list generated for Alexandria of the child fields for each of four major formats the project was working with—map; air photo; satellite image; and digital data set. Another problem that occurs is, if one is using 772$w, why bother anymore with 4xx/8xx? The tentative answer seems to be that one still may use 4xx/8xx for items in monographic series such as the U.S. Geological Survey folded-map series (GQ, I, MF, etc.). Still, it could come in handy for such subseries as the many Atlas of Mars subseries in the I series.

The best way to handle this seems to be the following:

a. use a tree analogy, with root-branch-leaf relationship—root as parent, branch as subseries, leaf as child;
b. have a field, as the Canadians did, that indicates what any given record is in relationship to other records;

c. link the fields with 772$w; for example:

Level 1 (root)	Parent record	
	RSN92850219 [control number; 001]	
Level 2	Sub-group	Item
	RSN92850226	RSN92850223
	772$w92850219	772$w92850219
Level 3	Item	Item
	RSN92850228	RSN92850227
	772$w92850226	772$w92850226 (Parker, 1990, p. 88)

d. when a user calls up a child, have software call the parent record. When the user calls up a parent and then requests all the children, have the standard response "This retrieves more than 5,000 records and will take 20 minutes; would you like to refine your search?" if there are a large number of children/leaves.

Another matter of interest here is linking related materials—e.g., DEMs and DLGs to the USGS quadrangles from which the data were digitized—but this can be handled within existing cataloging fields. *Guidelines for Bilbliographic Description of Reproductions* (Association for Library Collections & Technical Services, 1995) neatly sidesteps this matter and does not include digital forms of an item (e.g., a raster scan of a specific nautical chart is not a reproduction of the specific chart).

What to Catalog

For its prototype, Alexandria scanned any nondigital items that were cataloged thus creating a digital file. So what does one do? Create a catalog record for the digital file? Alexandria stopped with creating the digital file and did not catalog it, but there is no reason why one has to stop there and many reasons to continue on. One needs to create a record for the scanned object, but it should be closely connected to the record for the original item, perhaps as a version of it. As Barbara Tillett (1995) put it so well in her paper on multiple versions as a digital equivalent of the supremely useful "dashed-on" entry from pre-USMARC days.

Subject Headings

There are a couple of subjects that need some work. Satellites should be referred to in a consistent fashion. Currently, we have both: Landsat satellites and SPOT (artificial satellite). The latter looks the more logical of the two.

A primary part of any geospatial-digital-data reference question is, "Is the data raster or vector?" With the new Content Standards for Digital Geospatial Metadata fields, USMARC does have a field specifically to note this, but given the importance of the question, perhaps we should also have a subject heading for each. "Linear topographical spaces" seems to be how vector data sets are presently referred to in LCSH. There does not seem to be a subject heading for raster data.

This is not a subject heading relating solely to digital geospatial data. It is included here on the grounds that so much imagery of other planets in the solar system is in digital form, and it was that data that brought this problem—which previously had irritated me but not enough to do anything about it—most forcibly to my attention. We do not deal consistently with planetospatial data of Earth in LCSH. For other planets we have: Venus (Planet), Jupiter (Planet), and so on. We do not have, and very much need, Earth (Planet). This means that when one catalogs a geologic atlas of the Earth, the only LCSH subject heading one may use is: Geology $x Maps which plops it in with such works as the making and use of geologic maps.

Bounding Coordinates

With very few exceptions, every reference question for planetospatial data starts out with location. So, having quickly determined bounding coordinates are essential. For spatial data in digital form, this information is often in the header or derivable from inside the digital data. For aerial photographs, deriving it is a nightmare. We need software that determines these coordinates, and GIS and image processing software may have the answers needed.

Also, what about coordinates for other planets? USMARC and Content Standards for Digital Geospatial Metadata both assume Planet Earth coordinates. We need a field—perhaps an indicator—that signals what planet is meant.

Time

When time becomes a matter of metadata interest, then we must specify what kind of time is involved (local time? Greenwich time?), and we need a field that tells the reader of the metadata what kind of time is meant.

CONCLUSION: TIME OF CHANGE

Some years ago, the cataloging community was the most conservative part of the library world, the least willing to consider change. Then, in short order, we got MARC, shared online cataloging, and AACR2, all of which quickly eliminated anyone who was resistant to change (I can still remember catalogers who took early retirement rather than to deal with AACR2). The cataloging community has shown itself, especially over the last five years, to be very responsive to change, willing to put together a set of rules for cataloging new formats (e.g., data available over the Internet) in short order and send these out to the wider community to be tried out. Certainly MARC has its faults, and certainly the library world is looking at next steps (e.g., SGML). However, it has been both extraordinarily useful and extraordinarily successful, being adopted in one form or another internationally, and there are perhaps 60 million USMARC records in existence. It is important to remember that MARC was formulated at a time when computer power was far less powerful and far more expensive than it is now, from whence came many of the coded fields (contained generally in 001-049). What would be most helpful now would be if the cataloging community would take on the very difficult task of reworking the cataloging rules so that they are even more based on cataloging information and not on cataloging the book form.

Speaking more specifically, over the last six months it has become increasingly obvious that, for a cataloger to catalog digital planetospatial data accurately and quickly, the cataloger must know a considerable amount about such data—how to load it, how to read headers, how to scan materials and do image processing on the resulting files, and so on. Alexandria depended on two very capable, hard-working geography graduate students, one specializing in raster data and one in vector. Even as a short-term situation, this did not work perfectly. One needs the combination of knowledge of cataloging policy and practice and knowledge of how to deal with the digital side in order to produce good catalog records.

NOTE

[1] Scale is not logically applied to digital spatial data sets; scale of hard-copy data used for inputting is not the same as the scale of a specific hard-copy map being cataloged. More tellingly, the implication here—that a digital planetospatial data set may be displayed at only one scale—is not correct. The equivalent information for digital data is resolution which, no matter at what scale the data are displayed on a screen, remains the same. For example, the horizontal spatial accuracy of 1:24K DEMs is 30 meters; the 1:250K DEMs have a spatial accuracy that is tied to latitude—3 arc-seconds up to 50 degrees North, 6 arc-seconds from 50 to 70 degrees North, and 9 arc-seconds above 70 degrees North.

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