The ARSUP Database and Its Access through the CMCIRS Catalog: Making Available to the Public Digital Maps from the ARSUP Process

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ABSTRACT: The ARSUP (Automated Rectangular Survey Plat) database has evolved with the development of the ARSUP process. The database was created using the AHDS (Alaska Hydrography Digitizing System) software developed at the Bureau of Land Management's Alaska State Office. The ARSUP database is currently being added to the Alaska State Office's CMCIRS (Computerized Map Cataloging and Information Retrieval System) catalog. The structure of the ARSUP database is defined—including the organization of the data files within the database, the attributes of the data layers, and the structure of data within the data files—and the location and accessibility of the database is identified. An overview of CMCIRS is provided, including how CMCIRS can be used to identify and locate ARSUP as well as other digital and analog maps, and ortho photography and aerial photography indexes maintained at BLM's Alaska State Office.

BACKGROUND

CURRENTLY, the primary effort at BLM-Alaska revolves around surveying and conveying lands selected by the State of Alaska, as provided by the Alaska Statehood Act of 1959 (72 Stat. 339-343), and lands selected by Alaska Native regional and village corporations under the provisions of the Alaska Native Claims Settlement Act (ANCSA) of 1971 (85 Stat. 688-715). Under their respective Acts, the State of Alaska was allowed to select 104.5 million acres (42.3 million hectares) and the Native corporations 44 million acres (17.9 million hectares). In addition, because of "*in lieu*" selection rights for mineral reserves, another 4 million acres (1.6 million hectares) will have to be surveyed, making 48 million acres (19.5 hectares) total in order to meet ANCSA requirements (Sanders and Eickbush, 1986). These selections must be surveyed and legally described before patent can be issued. As of July 1987, some 70 million acres (28.3 million hectares) have been surveyed with approximately 29.2 million acres (11.8 million hectares) patented to the State of Alaska and 5.1 million acres (2 million hectares) patented to the various native corporations.

These surveys depict upland as surveyable land (less any exclusions), lot these areas, and return acreages for them. They also depict as exclusions those areas of previously surveyed or patented lands, and all meanderable waters. Meanderable waters are currently defined as navigable waterways, coastal areas below mean high tide, lakes 50 acres (20.25 hectares) or larger, and rivers and streams 3 chains (60.35 metres) in width or greater that do not fall into any of the three previous categories. Further clarifying the definition of meanderable waters is the fact that swamps, bogs, and marshes on federal lands in Alaska are classified as upland and subject to survey and patent, because the various "Swamp Lands Acts" (9 Stat. 352, 9 Stat. 519, and 12 Stat. 3) were never extended to include the State (U.S.D.I., 1973 and White, 1983). Even with this modified definition of meanderable waters there are still major portions of the State, mainly in, although not limited to, areas of delta and tundra, where the hydrographic structure is extremely complex (see Figure 1), and the logistics and costs of ground or aerial survey of meanderlines (upland - meanderable water interface) is prohibitive.

BLM-Alaska's Cadastral Survey, the division with the assigned duties of land surveying and providing legal descriptions of those surveyed lands, has tried several methods of delineating these meanderlines with varying success. The first method tried was to take the meanderline data, in analog format, from existing published maps. This was not successful due to the map scale (varying from 1:63,360 to 1:250,000), the age of the maps (most based on photography taken in the 1940s or 50s), the high rate of change and variability of the hydrographic systems involved, and the difference between Cadastral Survey's definition of hydrography and that used in producing the maps. Another method involved the use of black-and-white rectified photos to determine meanderlines. This failed due to the inability to discern sufficient detail and to accurately distinguish sufficient shades of gray (McCaffrey, 1983). Still another method has been to use the interpretation of recent high altitude false color infrared photos and black-and-white orthophotos in combination with ground truthing of diagnostic locations, by surveyors and photo interpreters, to delineate and confirm meanderlines. This last method has met with great success and is in use today (McCaffrey, 1983; Nakazawa and Vanderlinden, 1986). It has produced data for over 629 townships, or approximately 14.5 million acres (5.9 million hectares) to date, with data for another 380 townships in various stages of completion as of July 1987. The interpreted manuscript (Figure 2) from this method, after being converted to digital format and processed extensively, forms the basis for the ARSUP (Automated Rectangular Survey Plat) database (U.S.D.I., 1987d).

Beginning in 1985, BLM-Alaska developed a formal process to ensure that the surveying, platting, and conveyance of lands to the State of Alaska and Native corporations is accomplished in a coordinated, timely, and equitable fashion. This is called the Patent Plan Process. The Patent Plan Process has required that efforts in planning, surveying, photogrammetric analysis and processing, platting, land status, and land conveyance be coordinated so that each township, so processed, would be addressed as a coherent whole, allowing for the timely issuance of patent.

The Automated Rectangular Survey Plat (ARSUP) process is an outgrowth of the Patent Plan Process, encompassing the areas of survey data preparation, photogrammetric analysis and processing, and the creation of the ARSUPs (see Figure 3) and Master Title Plats (MTPs) (see Figure 4). The ARSUP process requires that rectangular survey data be converted to a digital format compatible with Alaska Hydrography Digitizing System (AHDS) software; that meanderlines for designated survey groups

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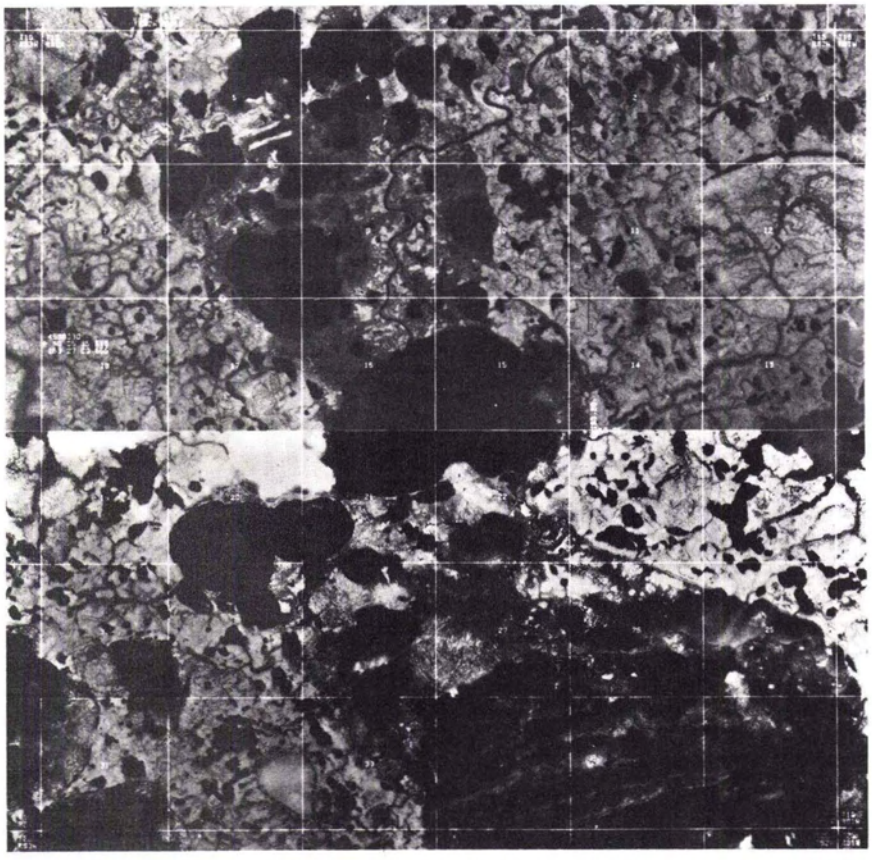

FIG. 1. Composite orthophoto with rectangular grid overlay of T. 1 S., R. 82 W., Seward Meridian, Alaska. This is used in conjunction with color infrared photography to interpret hydrography.

be generated, using the methods of photo interpretation mentioned above; that photo interpreted manuscript also be converted to AHDS format; that these two data sets, field survey and photo interpreted, be processed and combined to form a composite data set that conforms to survey requirements yet contains the vast amount and range of data of the photo interpreted data source, thus forming the ARSUP database; and that this database be used to produce the composite map bases for the required ARSUPs and MTPs (U.S.D.I., 1987a).

AHDS (Alaska Hydrography Digitizing System) is a Geographic Information System (GIS) software that has been developed at BLM's Alaska State Office over a period of more than ten years. In that time it has evolved from little more than a simple data capture (digitizing) system, to a more elaborate data collection system that included a Coordinate Geometry driven keyboard data entry element in addition to the data capture system, to a full blown GIS taylored specifically to collect and process data in support of the ARSUP process. In the early years of processing ARSUP data, AHDS was used in conjunction with MOSS — Map Overlay Statistical System (Dearborn, 1983). MOSS is a generalized GIS that was developed in 1977 and first implemented by Carl Reed, then employed by the U.S. Fish and Wildlife Service (Greenlee *et al.*, 1986). MOSS is currently maintained by Autometric Inc. At BLM-Alaska, MOSS had to be extensively modified to handle ARSUP data but never was able to produce results with the accuracy or efficiency needed because MOSS was unable to handle small scale maps and map elements such as are found in ARSUP data. With the increased need for accuracy and increased production requirements, MOSS was eventually replaced by new programs within AHDS.

ARSUP DIGITAL DATABASE

As previously stated, the ARSUP database is composed of elements from two different data sources: field survey records and photo interpreted meanderline manuscript. The field survey data (refer to U.S.D.I. (1973) and Pinkerton, (1986) for methods used to collect data) can come in analog or digital formats, of which analog is the most common. Analog records must be converted to a digital format, usually by key entry through AHDS. Any digital survey records must be translated into an AHDS format prior to processing and then must be incorporated into the database. The photo interpreted manuscript is digitized using AHDS software (the interpretation methods and criteria have been extensively detailed in McCaffrey (1983) and Nakazawa and Vanderlinden (1986) and will not be further covered in this article) and processed in combination with field survey data, with the goal of adjusting and conforming the photo interpreted data to match ground positions established in the field.

The ARSUP database is composed of three kinds of data files: field survey data files, hydrography data files, and lotted survey data files. Within the database will be found one, two, or all three kinds of data files for every township covered by the database. The files of the database are identified by a unique six digit suffix in the file name. The first digit of the six indicates the kind of data file: 9 for field survey files, 7 for hydrography files, and S or A for lotted survey files (S for files lotted only to the nearest section, and A for files lotted to the nearest aliquot parts). The last five digits form a unique township identifier called a Township Index Number. There is one unique five digit number for each of the 18,651 townships in Alaska (in the remainder of this article the Township Index Number will be rep-

FIG. 2. Photo interpreted manuscript for T. 1 S., R. 82 W., Seward Meridian, Alaska. Based on Figure 1 and color infrared photography and used to produce data for the ARSUP database.

resented by five stars: *****). The remainder of the file name, MDP., is standard and is the same for all files. MDP stands for Map Double Precision and the period in the file name is simply a separator.

Field survey data files, named MDP.9*****, derived from analog sources representing archival survey data from approved and platted surveys, or from current survey work accomplished using traditional ground survey methods, are manually input into ARSUP in several convenient data layers. Commonly used data layers are meander corners (corner refers to a measured survey location), witness corners to meander corners, rectangular corners, witness corners to rectangular corners, township corners, U.S. Survey corners, and Mineral Survey corners. In this context we may ignore the two kinds of witness corners. Meander corners are survey points representing the intersection of survey lines with meanderable waters (see previous section for the definition of meanderable). These data are used to control and adjust photo interpreted hydrography data during one of the processing stages in AHDS. Rectangular corners are survey points which occur as part of the rectangular survey grid. These points, when used in combination with the hydrography data, help determine the areas for which acreages are to be calculated. Township corners mark the four corners of a township. These data are used to control and position all other data during both the data collection (manual input and digitizing) and processing stages. U.S. Survey and Mineral Survey corners delineate the boundaries of areas to be excluded from acreage calculations and lotting, and as such are the only data layers in the field survey data that contain polygonal data. All the other layers are point data. To meet the processing requirements of AHDS, photo interpreted manuscripts are collected (digitized) as three discrete data layers, all of which contain polygonal data: hydrography to be filtered, hydrography to remain unfiltered, and islands. The "hydrography to be filtered" layer contains those data which are lakes. Because lakes must be at least 50 acres (20.25 hectares) in area in order to meet the meanderability requirement, these data must be filtered to eliminate all lakes under 50 acres. The "hydrography to remain unfiltered" layer, of course, contains all the hydrographic data that doesn't require filtering (all other hydrography). After filtering, these are combined to form a single hydrography data layer. The last "islands" layer contains those data polygons that, within the limits of the township map, are wholly surrounded by water. The combined hydrography layer and the island layer form the hydrography data file, named MDP.7*****.

The third kind of file found in the ARSUP database is the lotted survey file, named MDP.S***** or MDP.A*****, and is the result of processing and compositing survey and manuscript data. These resultant data are polygonal, the polygons representing the sections, quarter sections, and quarter quarter sections of a township, as may be required at the time of platting. This file also contains the acreages for each of those polygons.

Anyone wishing to access the ARSUP database, and to adapt its contents to their own computer system and software, will need to know the structure of ARSUP data files.

A detailed description of this structure, while not appropriate

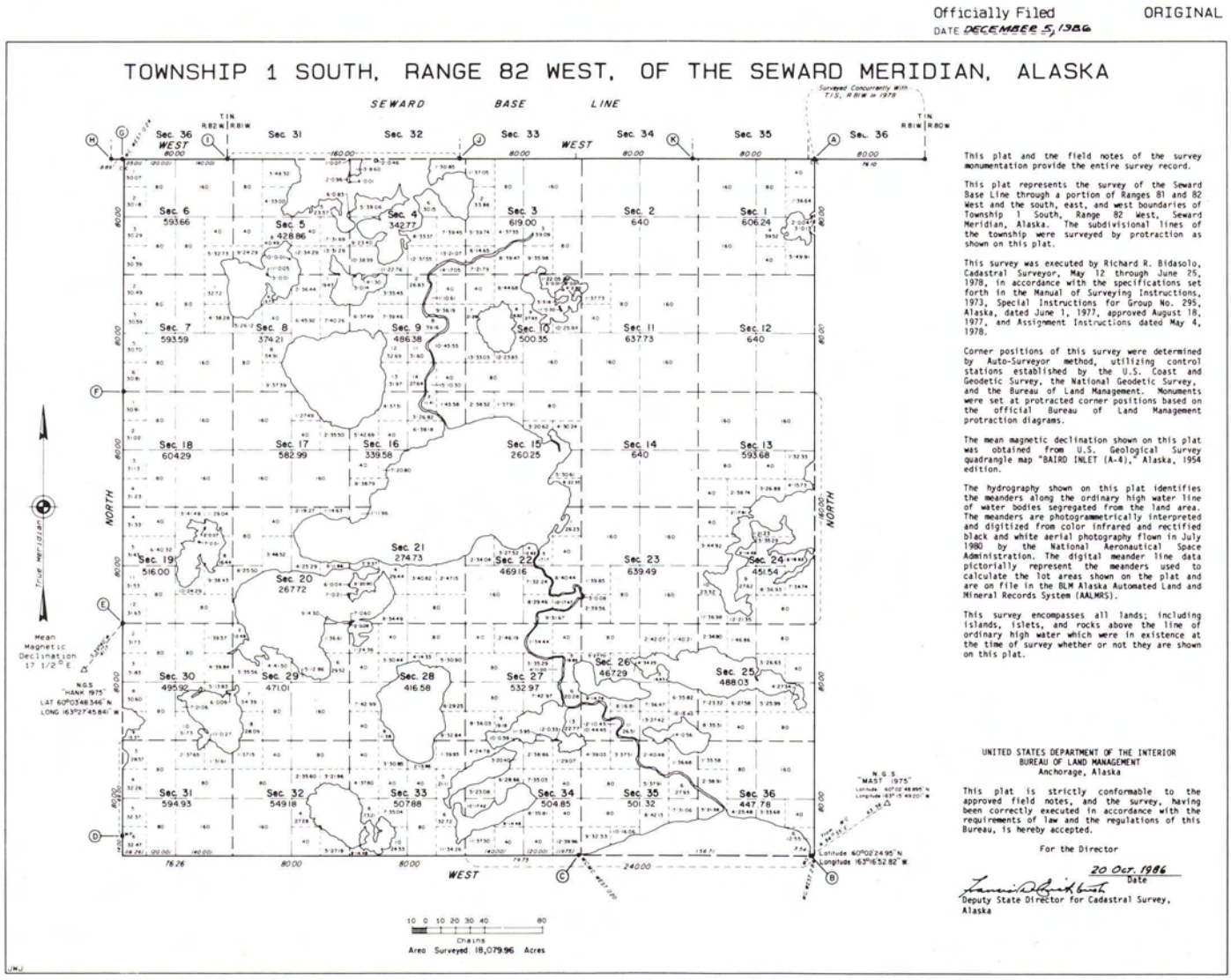

FIG. 3 Rectangular Survey Plat for T. 1 S., R. 82 W., Seward Meridian, Alaska. Produced using data from the ARSUP database.

to this discussion, can be obtained from the primary author through the Alaska State Office of BLM.

The above described data can be accessed through a digital catalog call CMCIRS.

CMCIRS

A computerized inventory of maps of Alaska lands has been developed by the Branch of Photogrammetry, Division of Cadastral Survey, USDI, Bureau of Land Management (BLM), Alaska State Office. The inventory system is named "The Computerized Map Cataloging and Information Retrieval System" (CMCIRS). As the name states, the purpose of the system is not only to inventory maps but to give information on the types and ownership/location of the maps available for use by Federal and State agencies as well as the general public. A major aim is to make it easy to locate maps that present specific resource or land-use information. The system is used to store map descriptions in computer files located in the Branch of Information Services of BLM-Alaska (currently, only BLM maps are described in CMCIRS, although this may change in the future). Additionally, the system has the capability of generating computer listings upon demand.

Currently, locating a map containing specific resource or land-use information is difficult. To find out if a map exists which fits your needs, you must be familiar with the types of maps produced by various State and Federal agencies and private businesses. Once you know that a map exists, you must find out where it is stored. Frequently, a map cannot be located and consequently a new map is recreated. This takes time and sometimes money.

Twenty-one critical elements have been created for CMCIRS. Under each critical element is a list of subtopics or attributes to which a four-digit code has been assigned. It is this code that is entered into the CMCIRS system which identifies valuable map information such as resource or land ownership/boundary information. A map can have as many as eight different critical element codes but must have at least one critical element code. Some of the subtopics are cross-coded and, in these instances, both codes should be entered into the system. It is this part of the coding form that map originators or map custodians need to elaborate on, for if CMCIRS is to provide the necessary information to the public that they need, they will be more inclined to use CMCIRS on a regular basis. Tables 1 through 4 are a few examples of the different types of critical elements with sub-

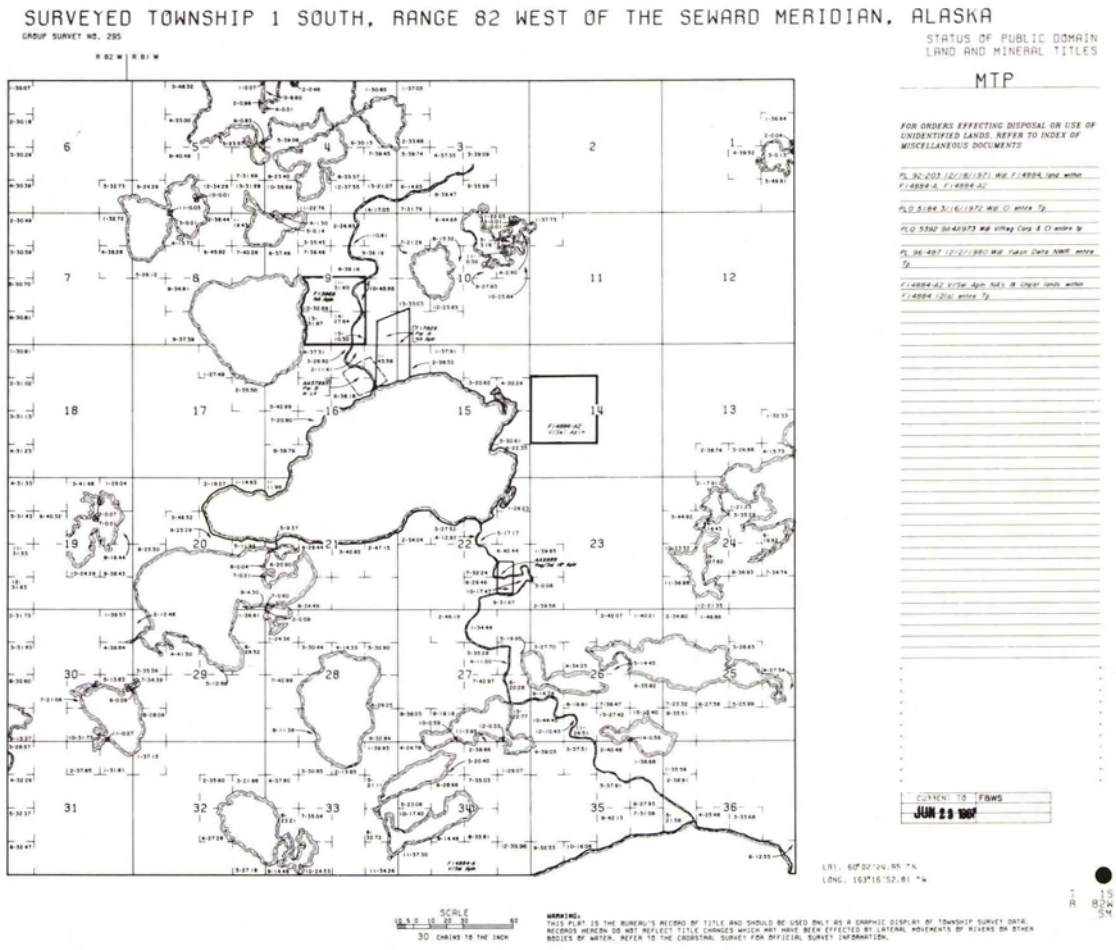

FIG. 4 Master Title Plat for T. 1 S., R. 82 W., Seward Meridian, Alaska. Produced using data from the ARSUP database.

Table 1 through 3 are excerpts taken from the Critical Elements and Attributes Section of the CMCIRS Manual (U.S.D.I., 1987b), giving examples of codes and subtopics used to categorize maps.

TABLE 1. GEOLOGY AND SOILS

CODE	
0301	Lineaments
0302	Drainage Net (see also Water Resources)
0303	Surficial Geology (see also Soil Survey)
0304	Paleontology
0305	Structural Geology
0306	Bedrock Geology
0307	Surface Disturbed Areas
	*Cross code to Limiting Physical Factors (Mass Movement)
0308	Geologic Hazards
	*Cross code to Limiting Physical Factors
0309	Mined Areas a) locatable
	b) leasable
	c) salable (material sites)
0310	Soil Surveys

TABLE 2. FISH & WILDLIFE

CODE	
0601	Big Game
	Black Bear
	Brown Bear
	Polar Bear
	Bison
	Caribou
	Sitka Black-Tail Deer
	Roosevelt Elk
	Mountain Goat
	Moose
	Muskoxen
	Mountain Goat
	Wolf *cross code to Furbearers
	Wolverine *cross code to Furbearers
0602	Furbearers
	Beaver
	Coyote
	Arctic Fox
	Red Fox

topics. Table 4 shows the critical element and subtopics related to the ARSUP Database (U.S.D.I., 1987c).

CMCIRS was designed to help shorten and simplify the steps to finding maps for many special needs. It enables users to locate maps simply by keying in commands to the computer system. In order for CMCIRS to be successful and become fully operable, existing maps are being entered now. BLM map originators and map custodians need to supply a good deal of information to enter their maps into the system. Once the existing maps are entered, map makers and users will need to supply information only on new, updated, and obsolete maps. With the cooperation and conscientious input of map originators and

TABLE 3. ENERGY/MINERALS

CODE	
1201	Energy Source (non-petroleum) Wind Solar Geothermal Hydroelectric
1202	Leasable Minerals (Petroleum) Oil & Gas Coal Oil Shale
1203	Locatable Minerals Copper Lead Zinc Gold Uranium Silver Molybdenum Platinum Mercury Other

Table 4 is an illustration of the newly created critical element and attribute codes for digital maps. These codes and subtopics will be expanded in the future to cover additional categories of digital maps.

TABLE 4. DIGITAL/ELECTRONIC MAPS

CODE	
2301	Hydrography
2302	Rectangular Survey Plat (ARSUP)

map custodians, the system will maintain an up-to-date inventory of all maps held by BLM in Alaska.

Along with the identity of specific maps, the system will have information on creation date, scale, geographic coverage, critical element/subtopic information, and whether or not the map can be reproduced. CMCIRS offers all the advantages of a central map library, with information accessible through a computer terminal. Yet, it allows map originators or major users to keep the maps in their offices.

CMCIRS is a cataloging system containing information *about* maps, not the physical maps themselves. The catalog contains a brief description of each map, including the geographic area it covers, the type of information mapped, and where the map is located.

The system has the ability to generate computer listings of all maps stored by attribute codes, Map ID number, and 1:250,000 USGS Quadrangle names. These listings are ordered from the Branch of Information Services, BLM, and will cover the entire state. These listings also can provide an alternate method of accessing information when it is inconvenient or impossible to use a computer terminal (i.e., computer down-time).

Users throughout the State will reap the benefits of on-line information retrievals. Anyone can then obtain or access map information by means of remote Beehive terminals that are linked to the Burroughs System at any of BLM's Alaska offices, including the Public Service Room (Public Room) in the Anchorage Federal Building. Resource management oriented State and Federal agencies will eventually have dial-in capabilities to CMCIRS. Dial-in capabilities for some agencies are currently being established.

Eventually, other agencies will have the option of entering their maps into the system, but for now only maps held by BLM Alaska offices can be entered. If BLM has a copy, any map regardless of its creator is entered into CMCIRS. Not every map needs to be entered, however. Maps that have been published and are readily available, such as USGS Quadrangles, and maps that are illustrations in published books and reports, should not be entered. Maps that contain classified information also should not be entered, because this system is available to the public.

CONCLUSIONS

BLM-Alaska is producing Automated Rectangular Survey Plats (ARSUP). As a part of this process, an ARSUP digital database has also been created. The individual map elements of this database can be located through the CMCIRS catalog. This catalog contains a combination of analog and digital BLM maps. A future goal is to eventually include analog and digital maps, from other State and Federal agencies in Alaska, in CMCIRS.

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REFERENCES

Dearborn, Barry C., 1983. *Automating Graphics Capability for BLM Plats*, Alaska State Office, Anchorage, Alaska.

Greenlee, David D., Jan W. Van Roessel, and Michael E. Wehde, 1986. *An Evaluation of Vector Based Geographic Information Systems at the EROS Data Center*, ESRI, Redlands, California.

McCaffrey, Cheryl A., 1983. Alaska Meanderlines Determined by Vegetation Appearance on Color Photographs, *Proceedings of the American Society of Photogrammetry Ninth Biennial Workshop on Color Aerial Photography in the Plant Sciences*, Orlando, Florida.

Nakazawa, Lynette, and Larry A. Vanderlinden, 1986. Survey Plat Meanderlines Determined by Photo Interpretation, *1986 ASPRS-ACSM Fall Convention ASPRS Technical Papers*, Falls Church, Virginia.

Pinkerton, Jerry, 1986. *Summary of Cadastral Survey in Alaska From Statehood to Present*, Alaska State Office, Anchorage Alaska.

Sanders, Horace D., and Francis D. Eickbush, 1986. "The Inception, Progress and Impacts of the Federal Land Survey Program in Alaska," presented at the ASPRS-ACSM Fall Convention, ACSM Section.

U.S. Department of Interior, Bureau of Land Management, 1973. *Manual of Instructions for the Survey of Public Lands in the United States, 1973*, U.S. Government Printing Office, Washington, D.C.

———, 1987a. *ARSUP Handbook: (Automated Rectangular Survey Plat Process)*, Alaska State Office, Anchorage, Alaska.

———, 1987b. *The BLM-Alaska Computerized Map Cataloging and Information Retrieval System (CMCIRS): A Manual for Coding Maps for Entry in a Computerized Inventory System*, Alaska State Office, Anchorage, Alaska.

———, 1987c. *The BLM-Alaska Computerized Map Cataloging and Information Retrieval System (CMCIRS): A Manual for Retrieval of Map Information from Computerized Inventory System*, Alaska State Office, Anchorage, Alaska.

———, 1987d. *Manual of Autocartographic Methods for Processing Photo Interpreted Data as Part of the ARSUP*, Alaska State Office, Anchorage, Alaska.

White, C. Albert, 1983. *A History of the Rectangular Survey System*, U.S. Government Printing Office, Washington, D.C.