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Fractal Compression

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Open File Report 97-126

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National Mapping Division

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Fractal Compression

I. Introduction

The National Mapping Division (NMD) US Geological Survey (USGS), has been evaluating and subsequently using data compression since it began producing digital orthophoto quadrangles (DOQ). The uncompressed DOQ data sets will require well in excess of 10 terabytes of storage once that data base is fully populated. Also, digital raster graphics (DRG) require a similarly large amount of storage space. When the DRG data base is complete, it will require roughly 2.3 terabytes. The NMD recognized that some form of compression was beneficial for distribution to users because of the large size of the files. The lossy compression of these large files saves space on storage media and distribution media, such as CD-ROMs, and also saves time in transmitting the files over a network. Some users find that the minimal information loss is acceptable and does not compromise their intended use of the DOQ data.

Storing and archiving the original uncompressed digital data on tapes is necessary to maintain all of the information. Because the compressed data offer a lower cost, easier distribution alternative, the NMD can reach a wider market that includes organizations that have smaller budgets, less powerful workstations, and less stringent file and image fidelity requirements than its traditional customers have.

Because of significant coverage in the technical press (see Appendix 1), the Office of the Division Chief, NMD, requested that System Development and Integration (SDI) staff investigate the feasibility of applying fractal compression technology to the digital cartographic data that the NMD must compile, store, and distribute. This study was accomplished through a contract with the Intergraph Corporation. FC Imaging (FCI), formerly known as Fed Comm International, was a subcontractor.

The Fractal Compression Study is part of a continuing effort by the NMD to investigate various compression techniques. Previous efforts in compression research by NMD's Western Mapping Center's (WMC) have yielded the following two related reports:

Data Compression Effectiveness on Digital Ortho Imagery Using JPEG Software
by Robert Vitales
USGS, Menlo Park, Calif.
May 1993

Any use of trade, product, or firm name is for descriptive purposes only and does not imply endorsement by the US Government.

Compression of Digital Othophotos
by John Villasenor, Ben Belzer, and Min-Jen Tsai
UCLA Electrical Engineering Department
September 1993

The second report compared wavelet-based compression technology to Joint Photographic Experts Group (JPEG) compression.

II. Current USGS Compression Techniques

A. Standard DRG's

The standard product is compressed in the following way:

1. For USGS - scan at 500 dots per inch (dpi), resample to 250 dpi
   The contractor (Land Info) scans in 250 dpi format

2. Georeference - does not affect file size

3. Standardize colors - reduce palette to 13 colors

4. Run length encoding (RLE) compression yielding a standard Tagged-Image File Format (TIFF) file.

5. Descreening

B. USGS - DOQ's

DOQ's are compressed using the JPEG image compression algorithm. The compression is applied to the final product and is also an intermediate step in the production process.

III. Fractal Compression Tests

The fractal compression tests were accomplished as follows:

A. Input.

1. DOQ's

   a. Southwest Atlanta, Ga.

b. Felix Peak, Mont.

2. DRG's

a. Jackson. Miss.
b. Output from the Product Generation (PG) software for:

(1) Arley, Mo.
(2) Calvert City, Ky.

B. Methods.

Intergraph Corp. first converted the files to 24-bit standard Microsoft format which is known as "bmp" because the software that they used required 24-bit bmp for input. Iterated, Inc.'s, Multiprocessor Image Toolkit (MPIT) software was used for the compression.

C. Compression.

Intergraph used the following compression technique:

> Iterated's MPIT is designed to take full advantage of symmetrical multiprocessor (SMP) systems (yet they aren't required for operation) and run reliably in both large-image and high-volume still image applications. On SMP/NT systems, MPIT converts large image files into a series of smaller segment panels then sends panel 1 to processor 1 , panel 2 to processor 2, and so on , (maximum of four processors) for compression. When a processor finishes compressing its assigned panel, the next panel in the image is sent to that open processor. This process continues until all panels are compressed and recompiled, resulting in the much smaller fractal image format (FIF) file. Compression ratios and time to compress are dependent on user-defined quality settings. The input file must be a 24-bit BMP file.

IV. Evaluation Criteria

A. Performance

1. Compression times varied according to the hardware configuration that was used (number of processors, Mb of RAM). The following compression table (table 1) shows fractal compression results for four different hardware configurations. No time information is available for

the current DRG compression method. The current JPEG compressions generally take less than 4 minutes on a Data General 530 using one CPU with 64 Mb of RAM.

2. The decompression table (table 2) indicates the time to open (decompress) and view each file for the various compression methods. All decompressions were performed on the same machine with the same number of other windows open.

(See the tables on the following pages)

B. Implementation Costs

At the moment the only costs would be the Iterated Systems, Inc. fractal compression software and Intel-based machines to run the software. The cost per license for the software is $3,500 per processor. Some customization is necessary to use the software. This price is for development (customization) only, but developing requires only one processor. The software uses multiple processors when it compresses. Currently, the viewing software is available only for the Microsoft Windows environment on the Internet at no charge. Iterated has stated that they have no plans to start charging for the viewing software. Also, they have given permission for other organizations, such as the NMD, to reproduce the viewing software on distribution media, such as CD's at no cost.

1. DRG cost estimate:

Assuming an average compression time of 1 hour per DRG and 54,000 DRG's (the number of USGS Quadrangles), then

1 hr x 54,000 = 54,000 hrs / 16 hrs =
3,375 days / 48 weeks = 10.04 yrs

This assumes that a batch job could be implemented to automatically start processing the next file as soon as the previous one finishes and that the machine(s) would run 16 hours/day, 48 weeks/yr. Also, personnel need not be present while these computer jobs are running. Therefore, jobs could be run overnight and during weekends.

If 10 machines with dual processors were purchased, then the entire job could be completed in a single year. Of course, the DRG data base is only partially populated; therefore, we would need fewer machines to

Table 1. COMPRESSION

File	Quality Factor	Input File Size (24 Bit Color)	Uncompressed File Size	USGS Standard Product File Size	Output File Size (FIF)	Ratio of Standard Product to Fractal Compression (x:1)	TD-5 / 2 P5 Intel CPUs 128MB Memory	ISMP64 / 4 P5 Intel CPUs 256MB Memory	TD-400 / 2 P6 Intel CPUs 64MB Memory	TD-400 / 4 P6 Intel CPUs 64MB Memory
DRG Calvert City, Ky		106.53	35.51	6.43						
	30				1.700	3.78	(1:04:51)	00:28:12	(0:28.36)	(0:14:45)
	50				4.100	1.57	(1:37:12)	00:42:20	00:43:57	(0:23:00)
	70				6.400	1.00	01:59:09	00:51:55	00:52:01	00:27:12
DRG Arley, Mo		106.53	35.51	3.96						
	30				1.200	3.30	(0:50:22)	00:21:54	00:21:33	(0:11:46)
	50				2.700	1.47	(1:12:00)	00:31:23	00:32:01	(0:16:03)
	70				4.200	0.94	(1:31:16)	00:39:41	00:38:10	00:20:19
DOQ Felix Peak, Mt		128.7	42.97	5.50						
	30				1.100	5.00	(1:31:51)	00:39:56	00:40:09	(0:21:00)
	50				3.000	1.83	(1:23:50)	00:36:27	00:36:49	(0:19:06)
	70				5.100	1.08	(1:31:51)	00:39:56	00:40:09	00:21.09
DOQ SW Atlanta, Ga		151.7	50.62	5.57						
	30				1.100	5.06	(1:06:58)	00:29:07	(0:30:00)	(0:15:10)
	50				2.800	1.99	(1:51:33)	00:48:30	(0:49:39)	(0:25:22)
	70				5.600	0.99	(2:15:10)	00:58:46	01:00:18	00:30:42

Notes: Items in () are calculated (projected) times (h.mm.ss) and are left justified; All actual times are right justified; Compression Compression rates in hh:mm:ss/Mb; All files sizes in Mb.

Table 2. Decompression (Load Times)

File	Input File Size (Mb)	Com-pressed File Size (Mb)	Compression Ratio (x:1)	Time hh:mm:ss	Time Ratio to Standard Product (x:1)
DRG's					
Jackson, Miss. (BMP)	42.12			00:03:17	0.845
Standard Jackson, Miss.	42.12	11.540	3.65	00:03:53	
Jackson, Miss. (FIF)	42.12	7.330	5.75	00:00:21	0.090
PG DRG's (BMP)					
Calvert_City, Ky.	35.51			00:02:48	0.757
Arley, Mo.	35.51			00:02:29	0.851
PG DRG's (standard)					
Calvert_City, Ky.	35.51	6.430	5.52	00:03:42	
Arley, Mo.	35.51	3.960	8.97	00:02:55	
PG DRG's (FIF)					
Calvert_City, Ky.	35.51	6.394	5.55	00:00:15	0.068
Arley, Mo.	35.51	4.210	8.43	00:00:17	0.097
DOQ's (uncompressed)					
Felix Peak, Mont.	42.97			00:05:47	1.483
SW Atlanta, Ga.	50.62			00:06:44	1.491
DOQ's (JPEG-standard)					
Felix Peak, Mont.	42.97	5.500	7.81	00:03:54	
SW Atlanta, Ga.	50.62	5.571	9.09	00:04:31	
DOQ's (FIF)					
Felix Peak, Mont.	42.97	6.120	7.02	00:00:13	0.056
SW Atlanta, Ga.	50.62	5.648	8.96	00:00:12	0.044

Notes: The column labeled "Time Ratio to Standard Product" is the ratio of the time to decompress that file to the time to decompress the standard product (JPEG for the DOQ's). "FIF" means fractal image file. "Standard" means the standard USGS product. "PG" means the output from the product generation software. "BMP" files are the uncompressed DRG's.

catch up in a single year. The exact number of machines depends on the percentage of DRG's that are complete when this compression technique is implemented. If more than two processors were purchased for each machine then the task could be shortened further. Each machine would cost about $10,000. Another implementation cost would be the cost of a programmer for minor software development because the software requires some tuning to fit the individual circumstances.

The total implementation costs would be as follows:

Hardware	$100,000	
Programming	$10,000	($50/hr x 200 hrs.)
License	$3,500	(*)
Total	$113,500	

* Only one license is necessary for development because executable modules can be distributed without individual licenses.

Realistically, only one machine may be necessary because the DRG's cannot be produced nearly as fast as they can be compressed.

2. DOQ cost estimate:

Assuming an average compression time of 1 hour per DOQ and 216,000 DOQ's (the number of USGS quarter quadrangles), then

1 hr x 216,000 = 216,000 hrs / 16 hrs =
13,500 days / 48 weeks = 40.18 yrs

This assumes that a batch job could be implemented to automatically start processing the next file as soon as the previous one finishes and that the machine(s) would run 16 hours/day, 48 weeks/yr. Also, personnel need not be present while these computer jobs are running. Therefore, jobs could be run overnight and during weekends.

If 40 machines having only dual processors were purchased, the entire job could be completed in a single year. Of course, the DOQ data base is only partially populated; therefore, we would need fewer machines to catch up in a single year. The exact number of machines depends on the percentage of DOQ's that are complete when this compression technique is implemented. If more than two processors were purchased for each

machine, the task could be shortened further. Each machine would cost about $10,000. Another implementation cost would be the salary of a programmer for minor software development. A programmer is needed because the software requires some tuning to fit the individual circumstances.

The total implementation costs would be :

Hardware	$400,000	
Programming	$10,000	($50/hr x 200 hrs.)
License	$3,500	(*)
Total	$413,500	

* Only one license is necessary for development because executable modules may be distributed without individual licenses.

Realistically, only one machine may be necessary because the DOQ's cannot be produced nearly as fast as they can be compressed.

C. Benefits

There are three potential benefits for using fractal compression. They are:

1. Smaller file sizes would reduce storage space and transmission times. Appendix 2 has information about an Internet demonstration related to this topic.

2. The fractal compressions appear to have better quality and accuracy than other techniques give (less loss). The fractal compressions appear to have less data loss, particularly in the case of the DRG's. More detailed and specifically quantified investigations are necessary in this area (see sec. V). A CD with sample compressions is being distributed with this report. The following is a list of criteria that should be used to judge fidelity and accuracy:

   a. Does the compression scheme move edges? How far?
   b. How much is their relative separation changed on a scan line-to-scan line and pixel-to-pixel basis? Dr. Villasenor's report (Compression of Digital Orthophotos) includes some excellent graphs that address these issues for discrete wavelet transform which is another compression technique.

c. The NMD should analyze the JPEG performance and use those numbers as indicators of the maximum acceptable ranges for these types of variations.

3. Faster decompression. The fractal compression of the Jackson, Miss., DRG took 21 seconds to load in the viewer. Its file size was 7,329,395 bytes. The standard DRG product for the same quad on the same machine with the same number of windows open took 3 minutes and 53 seconds to load in Adobe Photoshop. It had a file size of 11,538,508 bytes. The difference in performance while panning and zooming was similar.

D. Disadvantages

1. One of the major drawbacks of implementing fractal compression at this time is that the Commercial Off the Shelf (COTS) software only works on an Intel-based machine running some version of Microsoft Windows. Most user organizations have some of these machines, but any organization that does not would have to purchase one. This could be a hardship. The vendor has discussed the possibility of porting the software to other operating systems or platforms, but so far this has not been done.

2. Another disadvantage would be that the NMD would have to distribute the viewer with the data, free of charge. There is no monetary cost for NMD associated with it.

3. Currently, the free viewer is not powerful enough to be useful for most USGS customers. It can zoom in, but not out. It cannot pan, and it cannot generate files in different formats, such as JPEG or TIFF. The last deficiency would preclude overlaying images stored in a different format with images stored in the fractal format.

4. At this time, there are no widely accepted, commercially available applications. For instance, Adobe Photoshop does not accept the fractal format, even though it does accept most others.

5. Fractal compression lacks any national or international standards (see sec. E below).

E. Compression Software Maturity

1. There are no standards for this compression technique. However, only one company is defining the FIF file format. Standards do exist for the compression techniques currently in use for the NMD standard products.

2. The software is not available on most platforms (see above).

3. The system requirements for the Fractal Imager software are as follow:

   a. Shown below is the minimum configuration:
   Intel-based PC 486/33 or higher.
   Windows 95, Windows NT, or Windows 3.X. (Windows 3.X requires Win32's version 1.30.166, which can be installed from the Fractal Imager Web site or from a CD.)
   8 Mb RAM.
   Windows-compatible VGA or SVGA card.

   b. To get the best performance from Fractal Imager, you should use the following configuration, in addition to the requirements listed above:

   20 Mb free disk space for handling images.
   A 24-bit, true-color video card.
   16 Mb RAM.

   What are the impacts of these system requirements? Undoubtedly, the USGS would lose some customers. Would it be an acceptable number of lost customers?

4. There are other organizations using fractal compression technology. For instance, Intel Corp. has fractal compressed images at their World Wide Web (WWW) site. Copies of their web pages are in appendix 1. Also, MCI, in cooperation with the USGS, has a fractal demonstration on the WWW, and copies of these pages are in appendix 2. For more information on fractal compression technology and links to other fractal compressed galleries, visit the Iterated Systems, Inc., home page at URL http://www.iterated.com/.

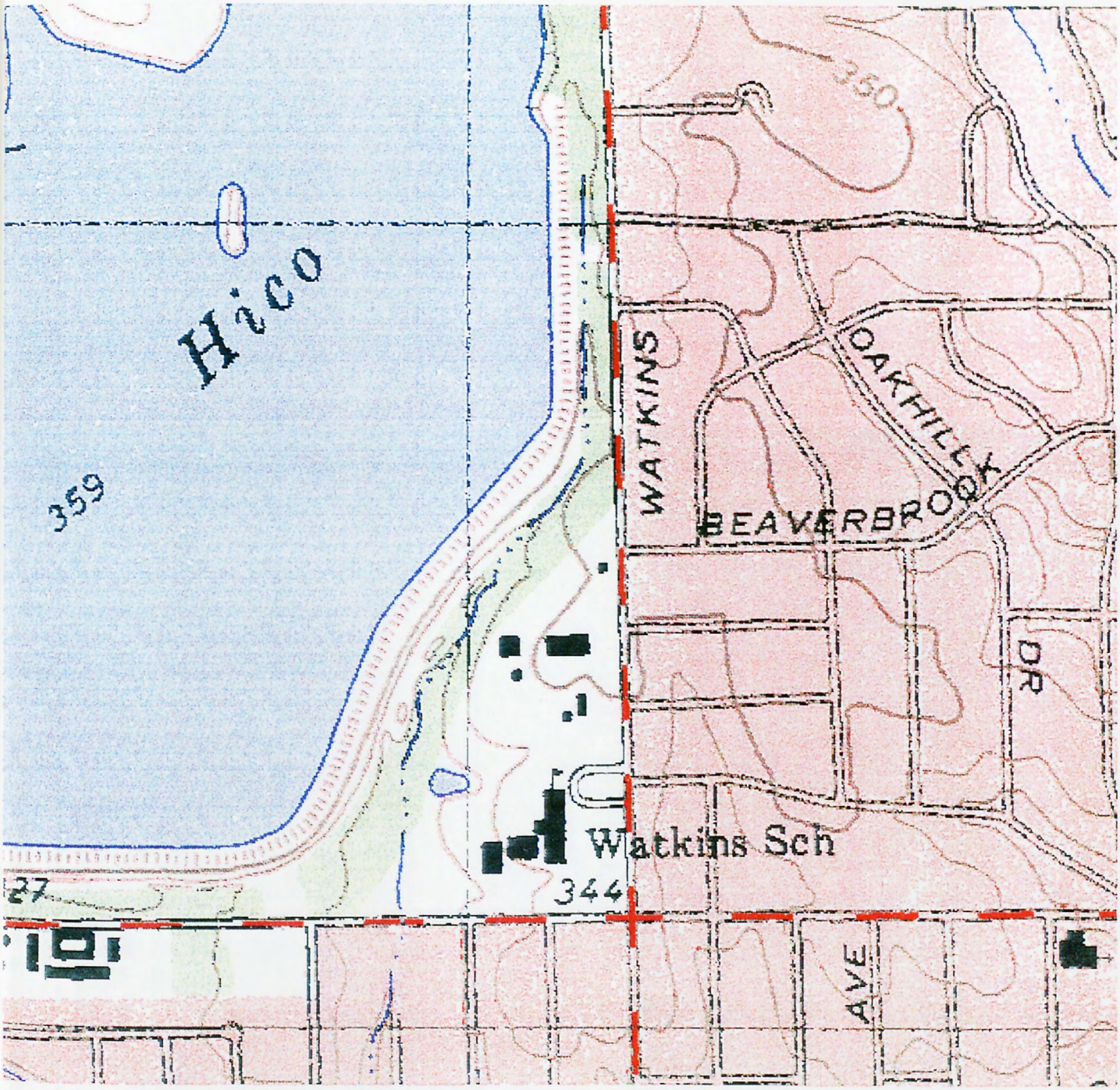
   Most of the companies that are primarily using fractal compression do so to save transmission time on networks, including the WWW, and to save storage space. MCI is currently studying the possibility of using fractal compression to transmit videos on demand. This idea can only be implemented if transmission times are small enough.

V. Summary and Conclusions

The study indicates several advantages of compressing image data in general and, more specifically advantages of using fractal compression technology for that purpose. The advantages of compression are that it saves space on both in-house storage media and distribution media such as CD-ROM's as well as saving time when transmitting the files over a network. Figures 1 through 14 at the end of this report are hardcopy reproductions of each compression method. Figure 3 is a 600 dpi scan of part of the Jackson, Miss. quadrangle. Figure 4 is the fractal compression of the 600 dpi scan. Notice that the quality of figure 4 is better than the quality of figure 1, which is the standard USGS product. Also, the fractal compression uses only 80.6 percent as much storage space. For the DOQ's, compare figures 10 and 13 (JPEG compressed) with figures 11 and 14 (fractal compressed). In the case of the DOQ's, the quality appears slightly better for the JPEG in roughly the same amount of space. The findings indicate that fractal compression can slightly decrease file sizes while giving as good or better image quality especially for the DRG's. Another important advantage is that it takes much less time to load the image into a viewer. The fractal compressions of the DRG's can be loaded in 8.5 percent of the time needed to load the standard product, on average. The DOQ's can be loaded in 5.0 percent of the time, on average. See table 2 for the specific differences in load times.

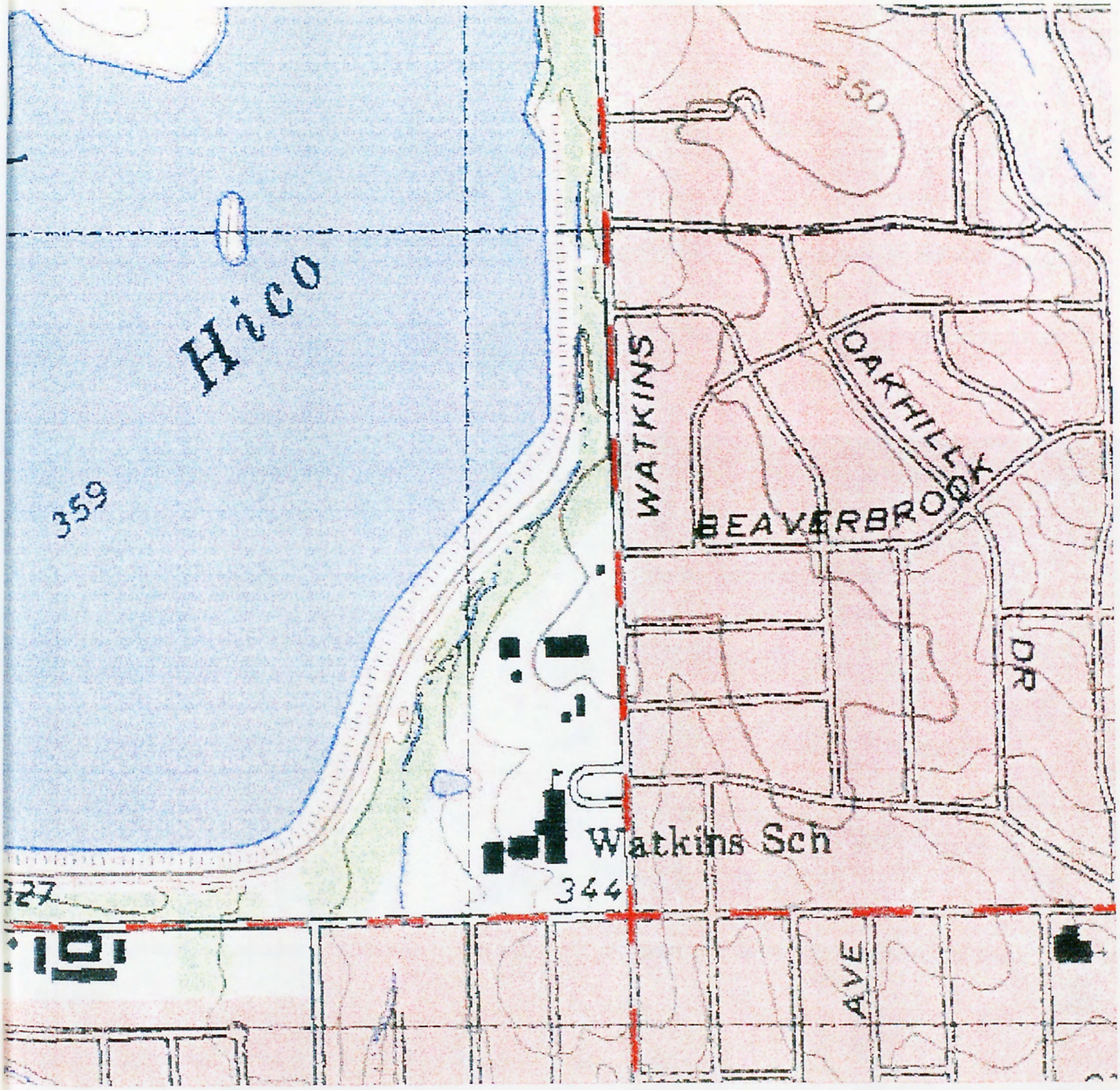
The author believes that fractal technology is not sufficiently perfected for use in our production processes and that the NMD program managers should monitor the further development of the fractal, wavelet, JPEG, and other compression technologies for incorporation. This study shows that the greatest potential benefit from using of fractals would be in the quality of the DRG's achieved by using an initial scan with more dpi while using fractal compression to limit the file sizes. Additionally, fractal compression has the potential to become a Division standard for all of our image data because it works equally well for both DRG's and DOQ's. At this time there is no standard format. JPEG is used to compress the DOQ's and RLE is used for DRG's because JPEG was found to be unsuitable for DRG compression. A standard format would provide the convenience of overlaying different types of images without the extra step of converting to a common format.

The following pages have printed examples of the image files. The images have been enlarged by a factor of roughly 3. This shows artifacts (patterns or marks that are a degradation of the original image) from compression better, and it minimizes the effects of the low-resolution printer that was used. It should be noted that the printer adds an additional amount of artifacting that may not be present in CRT viewing.



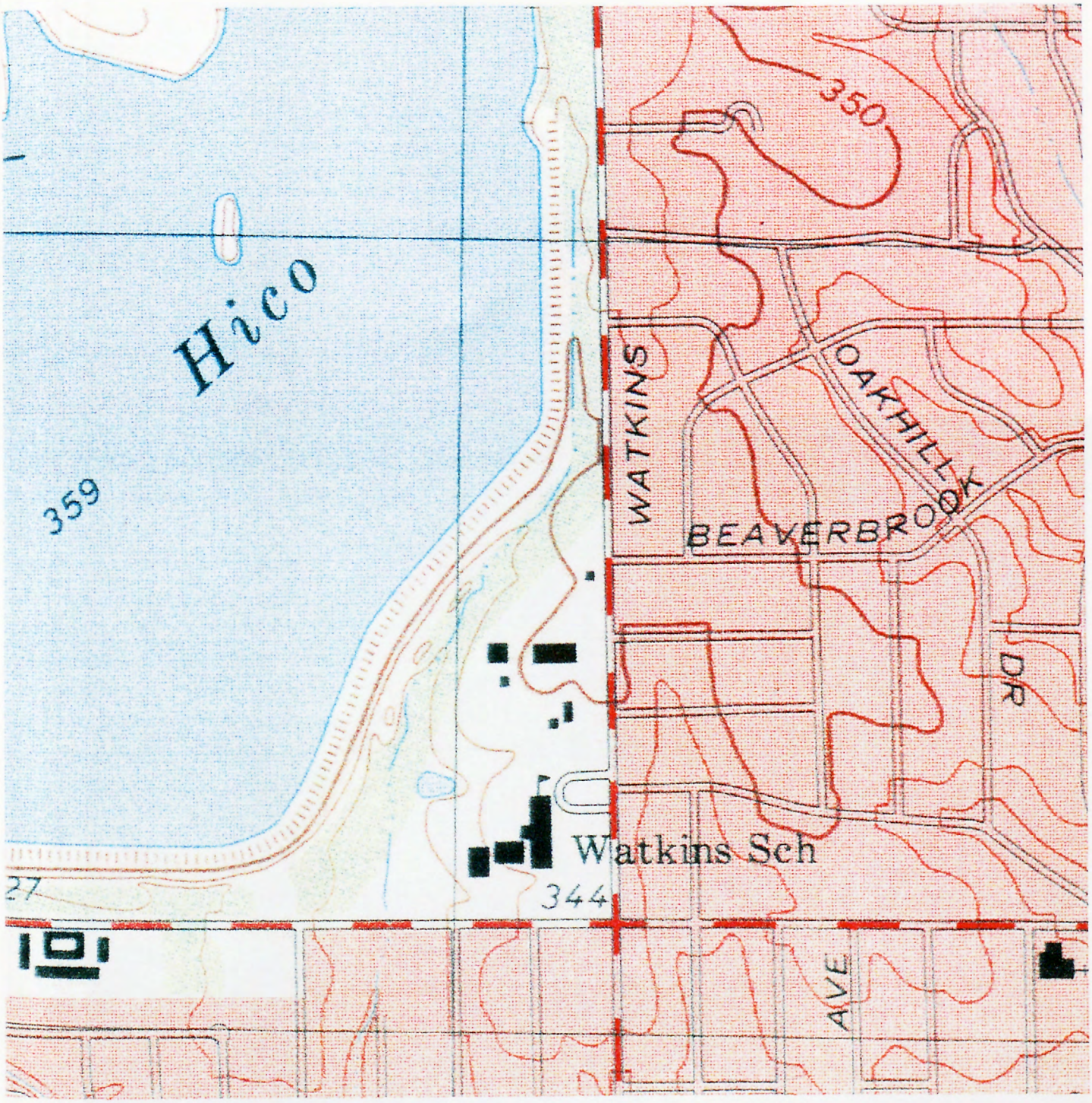
Compression Method - **ORIGINAL USGS INPUT FILE (RLE Compressed)**
File Name - **JCKSNMSG.TIF**
Source of File - **Standard USGS Digital Raster Graphic Product**
Compression Ratio with Input File - **N/A**
Compression Ratio with USGS Standard Product - **N/A**
Bytes/Square Inch - **19,425**

Figure 1



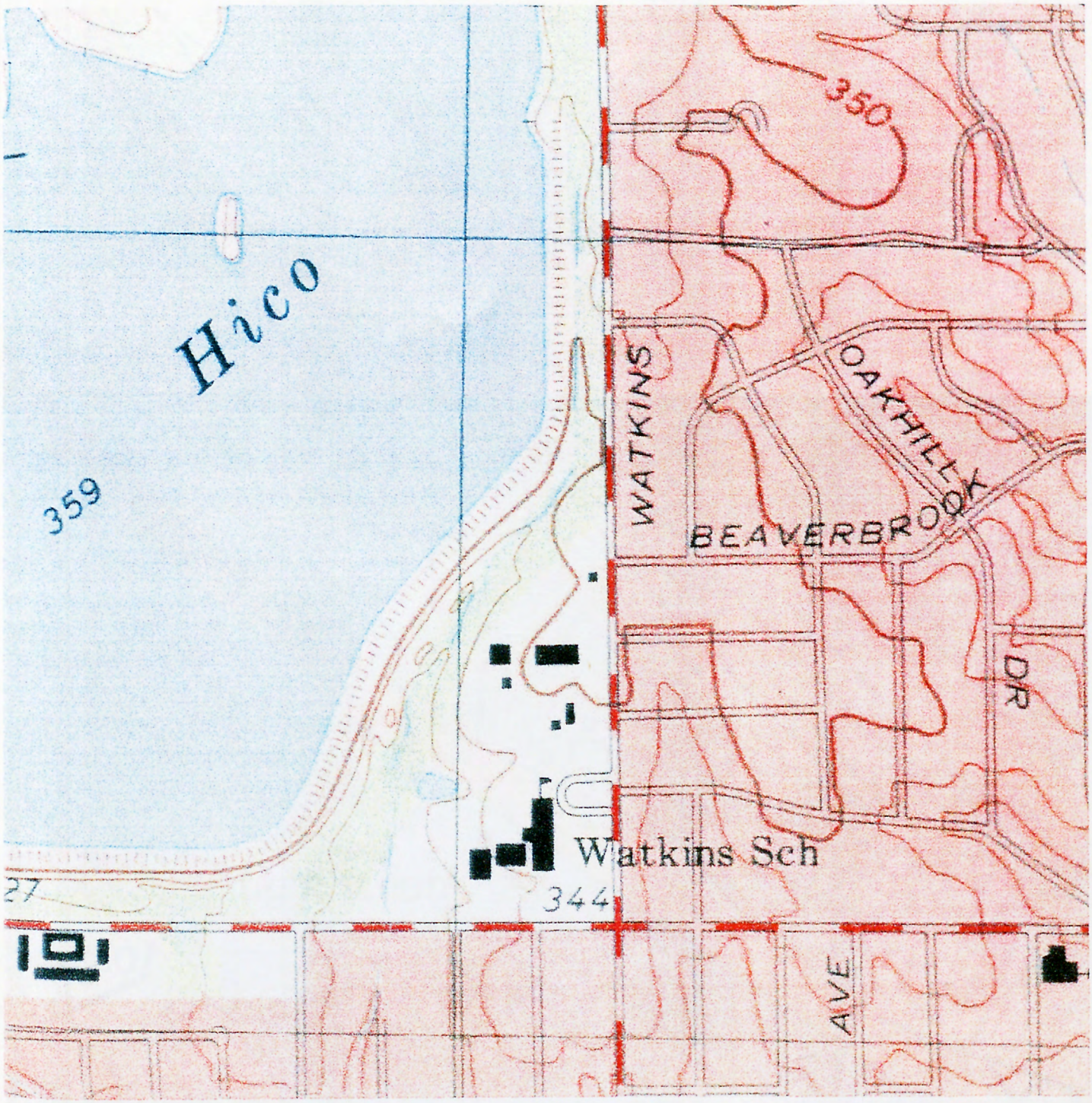
Compression Method - **Fractal Multiprocessor Image Toolkit (at high quality factor - 70)**
Input File - **JCKSNMSG.TIF**
Source of Original Input File - **Standard USGS Digital Raster Graphic Product**
Compression Ratio with Input File - **1.58:1**
Compression Ratio with USGS Standard Product - **1.58:1**
Bytes/Square Inch - **12,339**

Figure 2



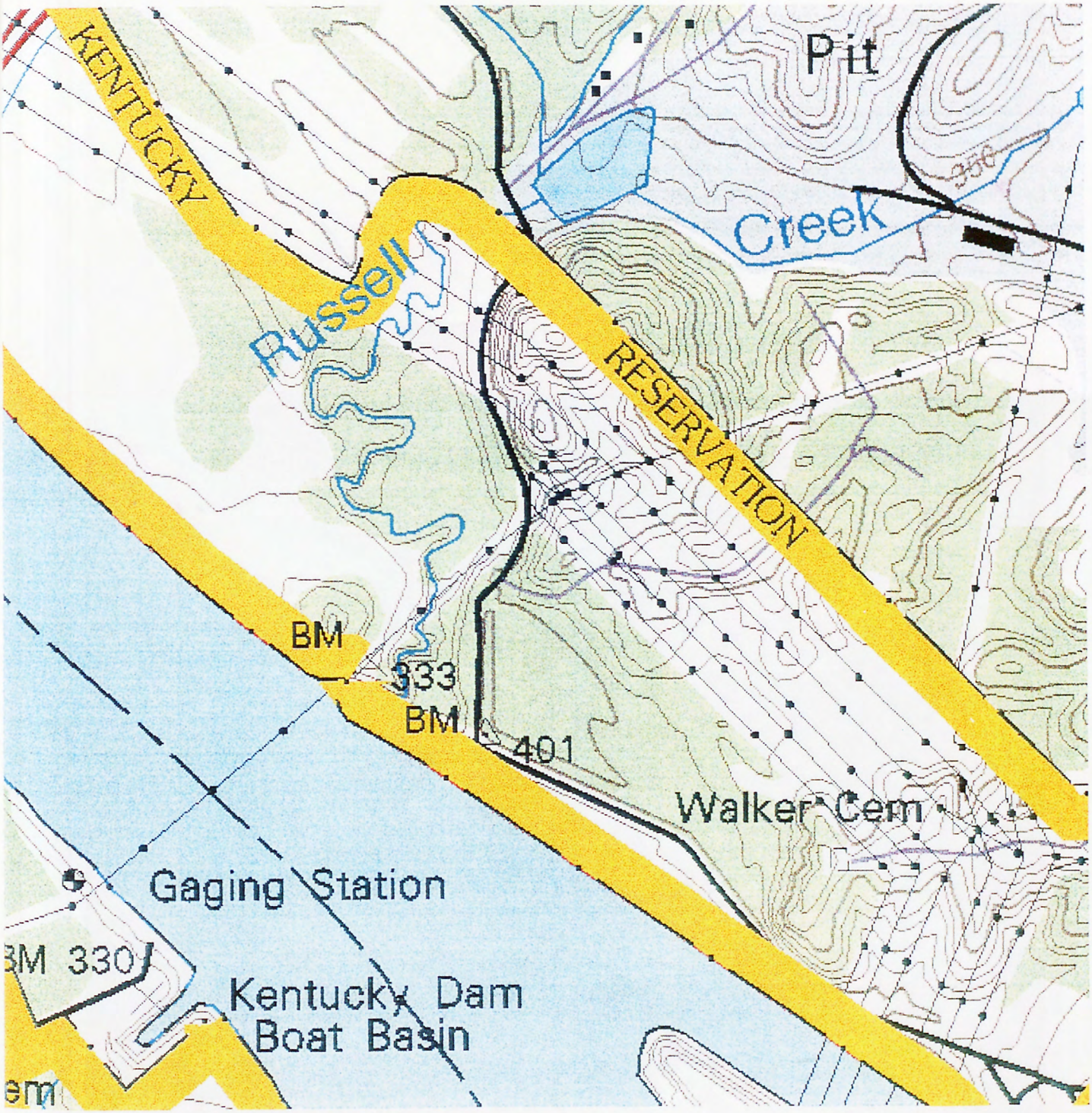
Compression Method - **N/A ORIGINAL INPUT FILE**
File Name - **JKMS600.TIF**
Source of File - **600 dpi scan of the Jackson, MS quad**
Compression Ratio with Input File - **N/A**
Compression Ratio with USGS Standard Product - **N/A**
Bytes/Square Inch - **871,831**

Figure 3



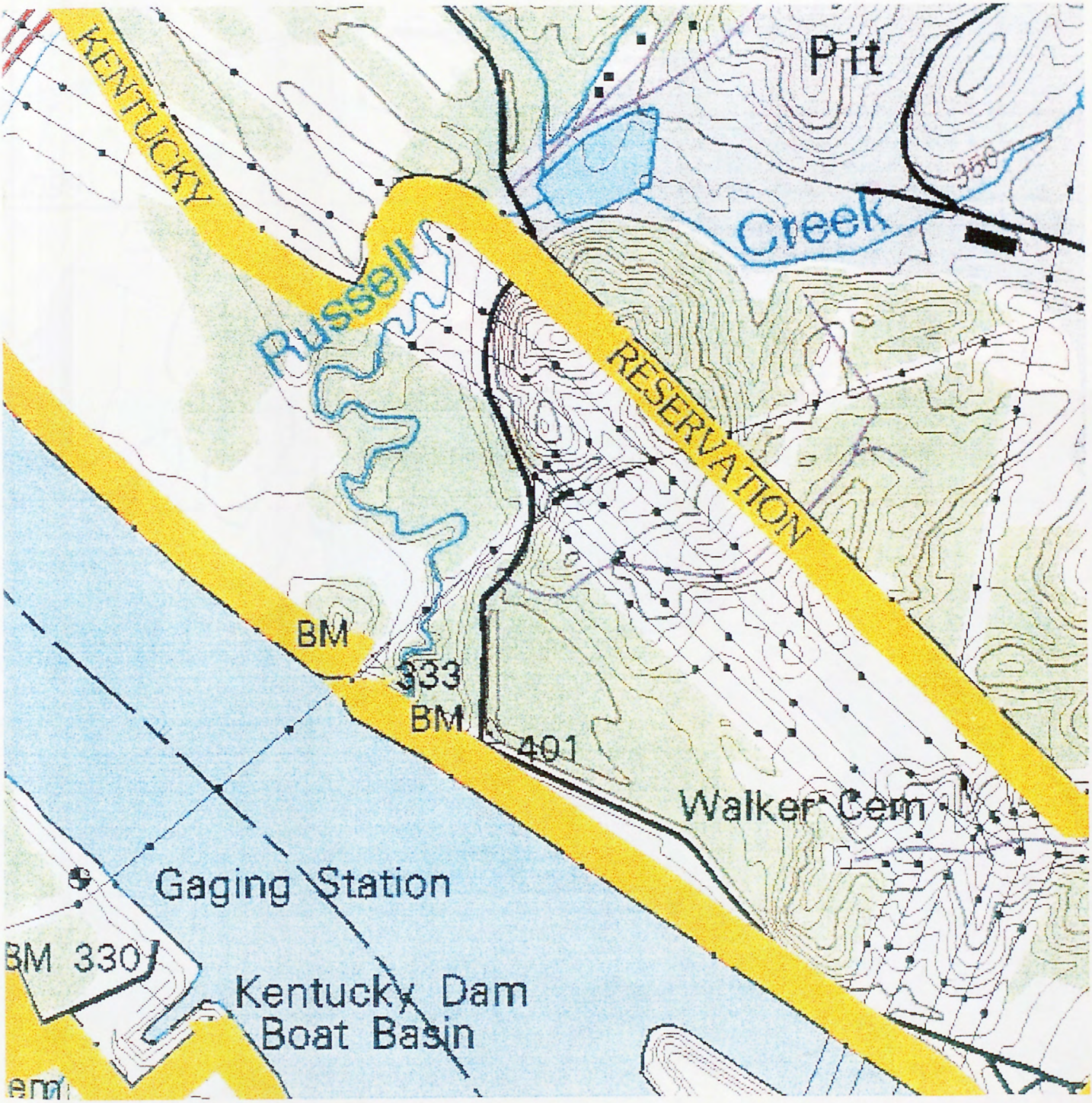
Compression Method - **Fractal Imager**
Input File - **JKMS600.TIF**
Source of Original Input File - **600 dpi scan of the Jackson, MS quad**
Compression Ratio with Input File - **55.7:1**
Compression Ratio with USGS Standard Product - **1.24:1**
Bytes/Square Inch - **15,653**

Figure 4



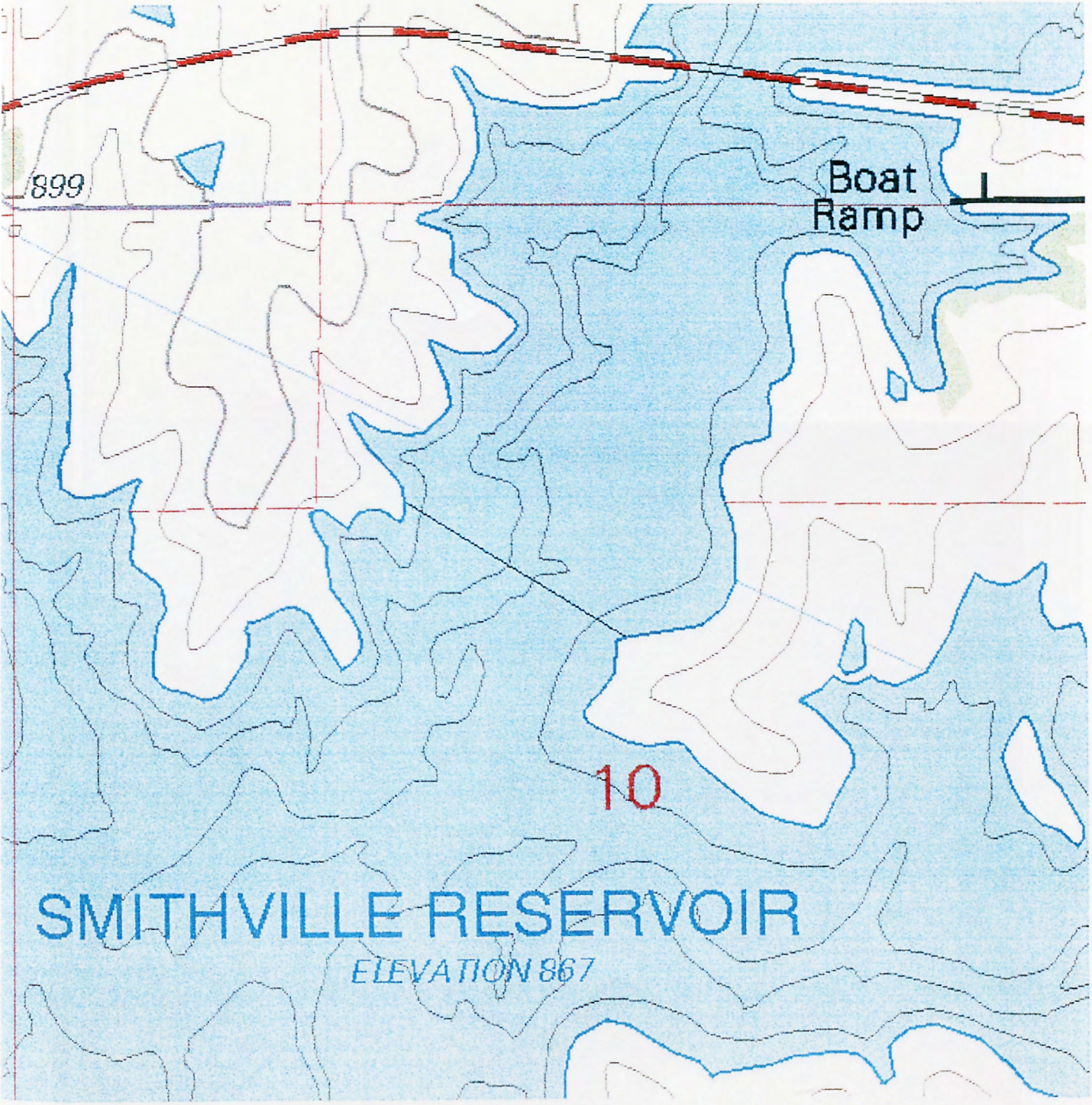
Compression Method - **N/A Original Input File**
File Name - **CAL_CITY.TIF (packed TIF format)**
Source of File - **DLG from PG**
Compression Ratio with Input File - **N/A**
Compression Ratio with USGS Standard Product - **N/A**
Bytes/Square Inch - **10,820**

Figure 5



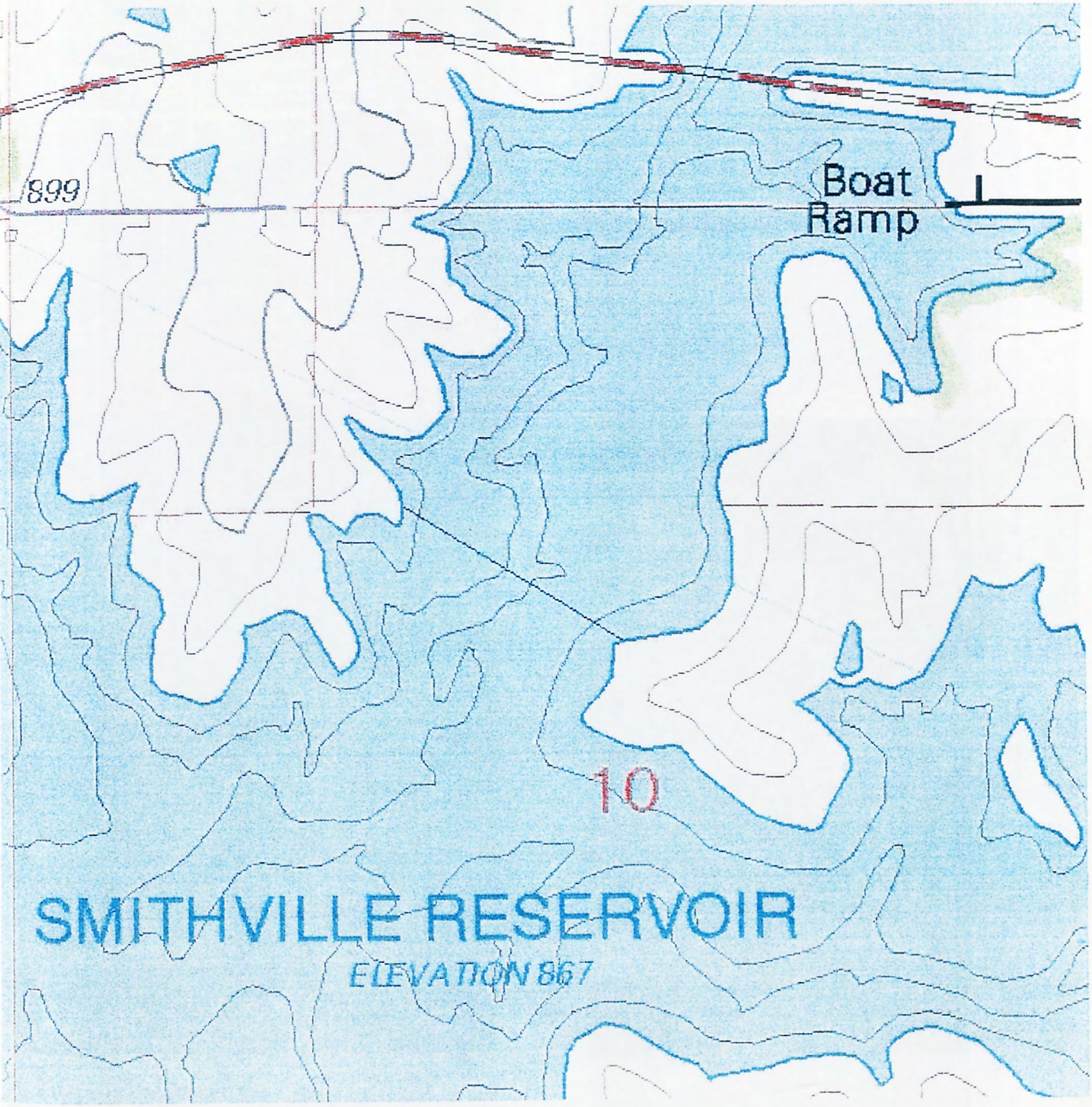
Compression Method - **Fractal Multiprocessor Image Toolkit (at high quality factor - 70)**
Input File - **CAL_CITY.TIF (packed TIF format)**
Source of Original Input File - **DLG from PG**
Compression Ratio with Input File - **1:1**
Compression Ratio with USGS Standard Product - **N/A**
Bytes/Square Inch - **10,764**

Figure 6



Compression Method - **N/A Original Input File**
File Name - **ARLEY_MO.TIF (packed TIF format)**
Source of File - **DLG from PG**
Compression Ratio with Input File - **N/A**
Compression Ratio with USGS Standard Product - **N/A**
Bytes/Square Inch - **6,672**

Figure 7

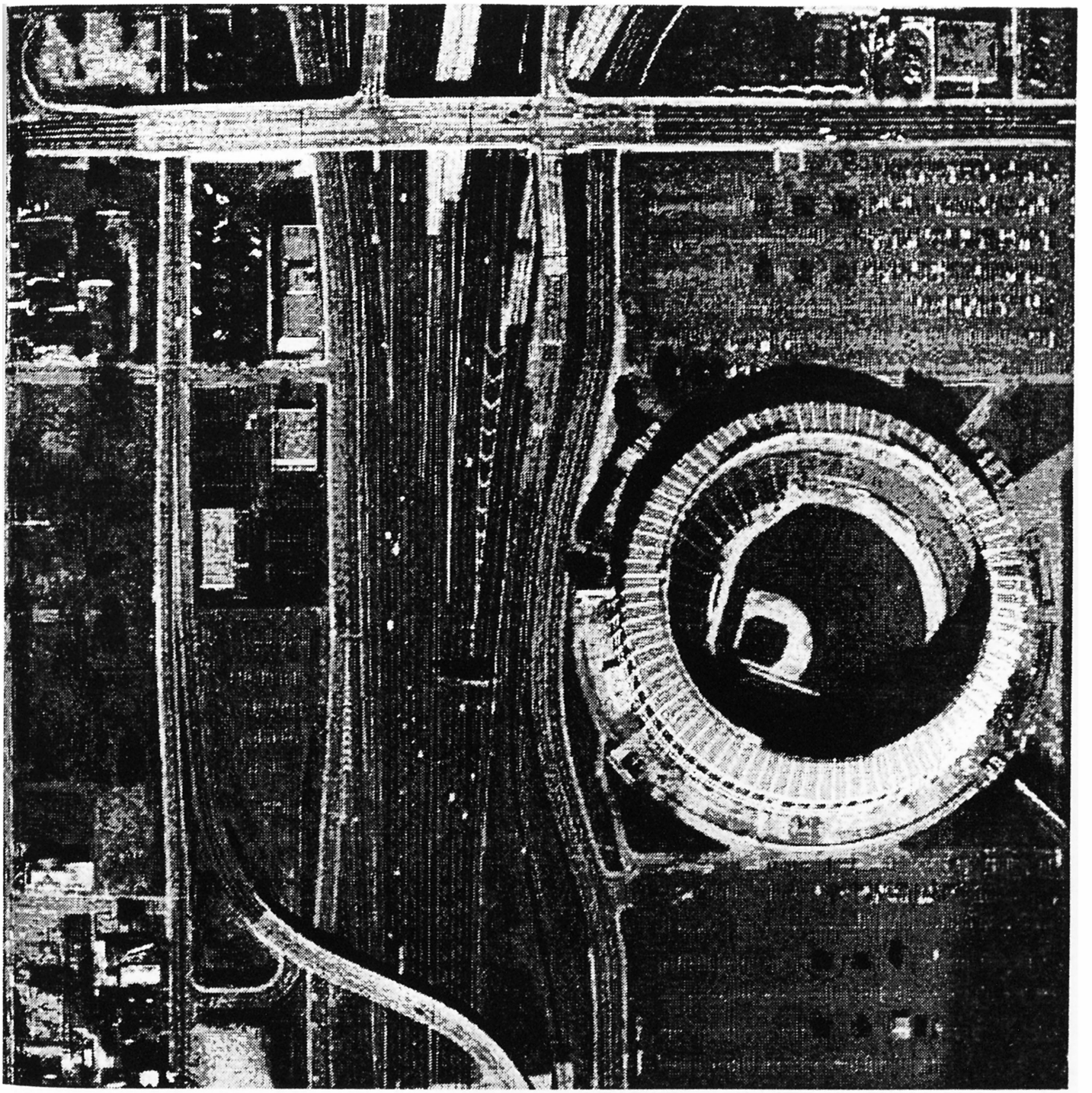


Compression Method - **Fractal Multiprocessor Image Toolkit** (at high quality factor - 70)
Input File - **ARLEY_MO.TIF (packed TIF format)**
Source of Original Input File - **DLG from PG**
Compression Ratio with Input File - **0.94:1**
Compression Ratio with USGS Standard Product - **N/A**
Bytes/Square Inch - **7,088**

Figure 8

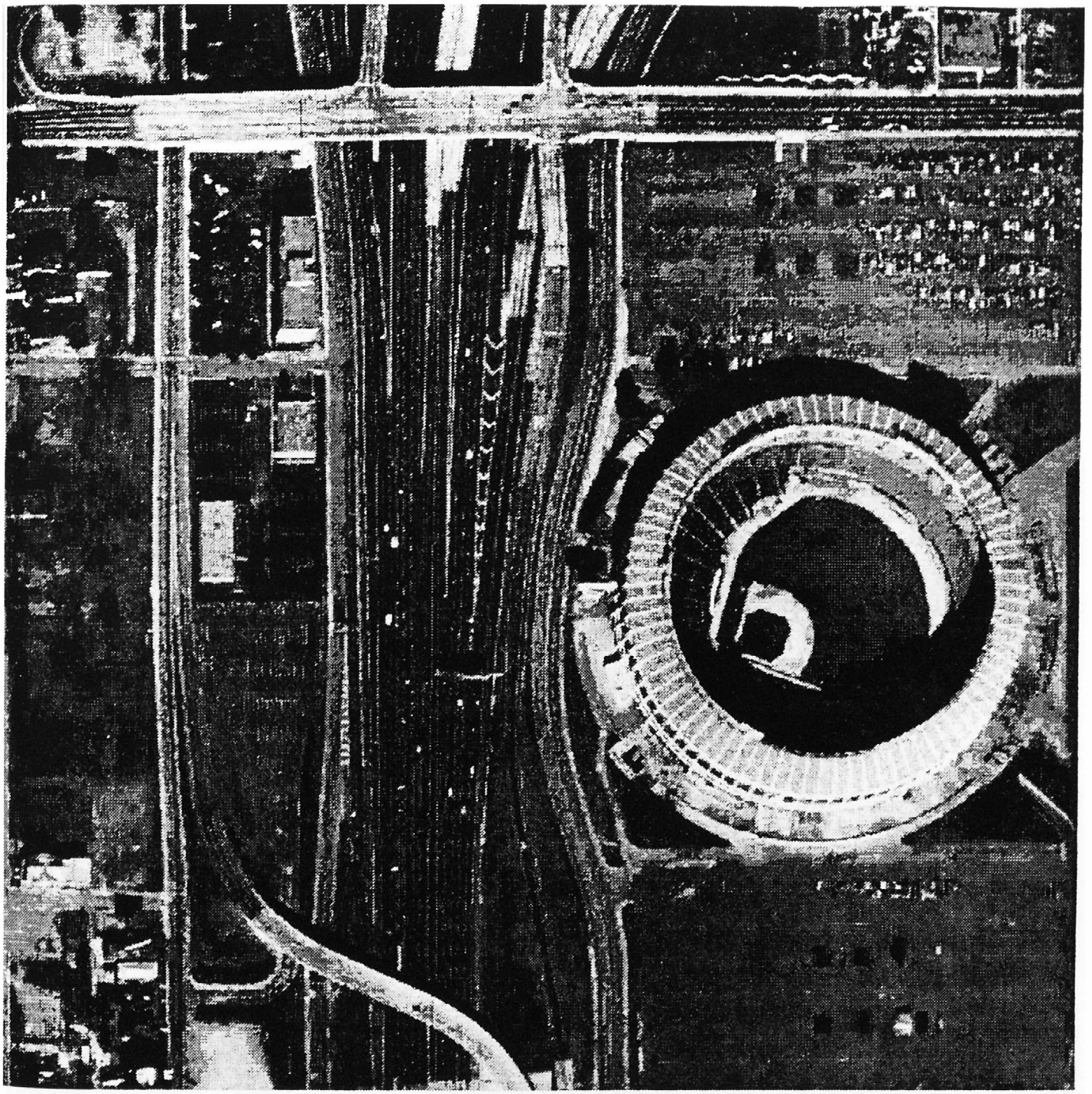
Compression Method - N/A Original Input File
File Name - GEORGIA.TIF
Source of File - USGS Digital Orthophoto Quarter Quad
Compression Ratio with Input File - N/A
Compression Ratio with USGS Standard Product - N/A
Bytes/Square Inch - 93,237

Figure 9



Compression Method - **JPEG**
Input File - **GEORGIA.TIF**
Source of Original Input File - **USGS Digital Orthophoto Quarter Quad**
Compression Ratio with Input File - **9.09:1**
Compression Ratio with USGS Standard Product - **N/A**
Bytes/Square Inch - **10,262**

Figure 10

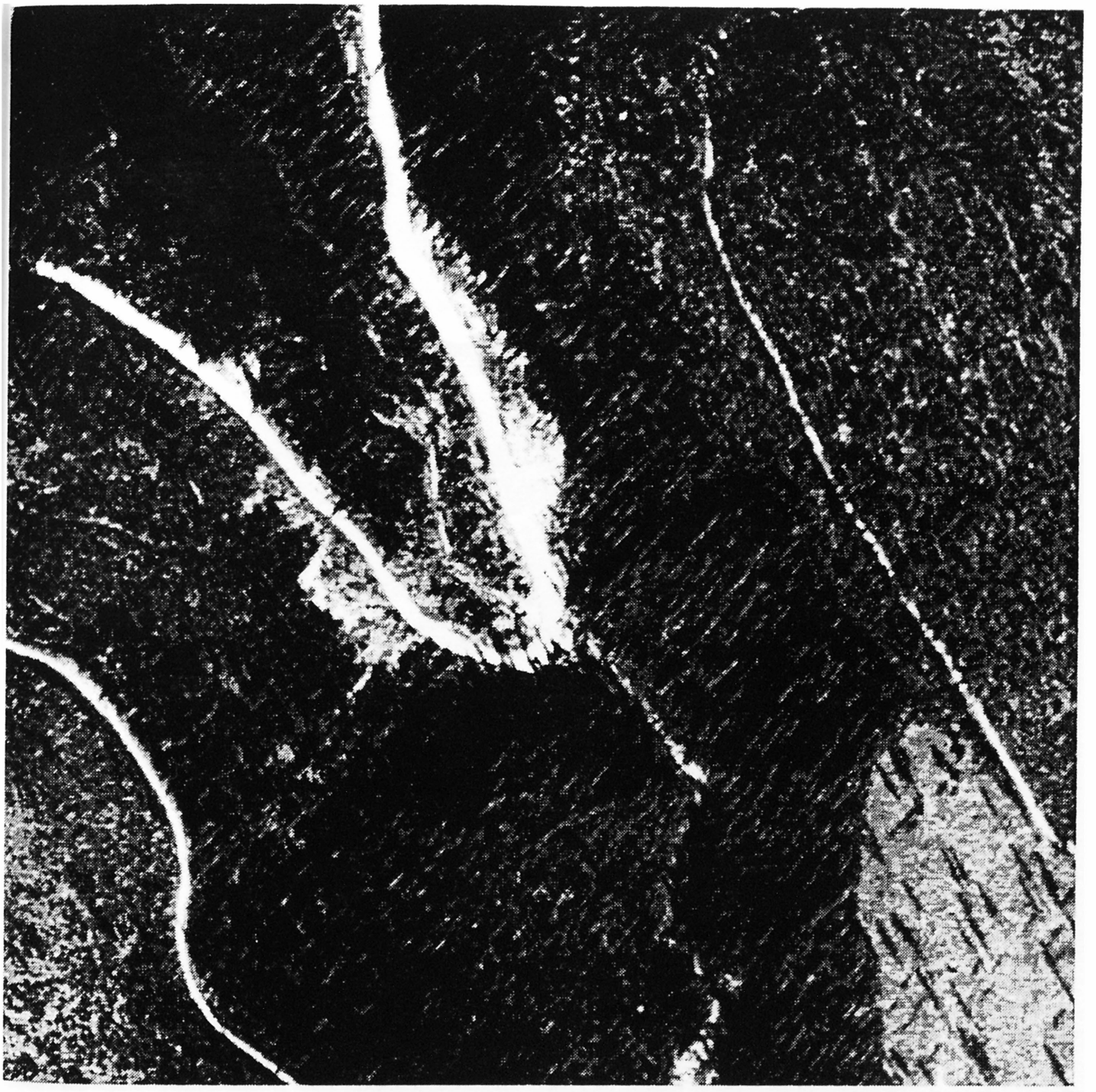


Compression Method - **Fractal Multiprocessor Image Toolkit (at high quality factor - 70)**
Input File - **GEORGIA.TIF**
Source of Original Input File - **USGS Digital Orthophoto Quarter Quad**
Compression Ratio with Input File - **8.96:1**
Compression Ratio with USGS Standard Product - **0.99:1**
Bytes/Square Inch - **10,404**

Figure 11

Compression Method - **N/A ORIGINAL INPUT FILE**
File Name - **MONTANA.TIF**
Source of File - **USGS Digital Orthophoto Quarter Quad**
Compression Ratio with Input File - **N/A**
Compression Ratio with USGS Standard Product - **N/A**
Bytes/Square Inch - **92,771**

Figure 12



Compression Method - **JPEG**
Input File - **MONTANA.TIF**
Source of Original Input File - **USGS Digital Orthophoto Quarter Quad**
Compression Ratio with Input File - **7.81:1**
Compression Ratio with USGS Standard Product - **N/A - This is the Standard Product**
Bytes/Square Inch - **11,873**

Figure 13

Compression Method - **Fractal Multiprocessor Image Toolkit (at high quality factor - 70)**
Input File - **MONTANA.TIF**
Source of Original Input File - **USGS Digital Orthophoto Quarter Quad**
Compression Ratio with Input File - **7:1**
Compression Ratio with USGS Standard Product - **0.9:1**
Bytes/Square Inch - **13,213**

Figure 14

Appendix 1

To receive your own regularly updated content, go to Custom News for You

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This site best viewed with Netscape 2.0

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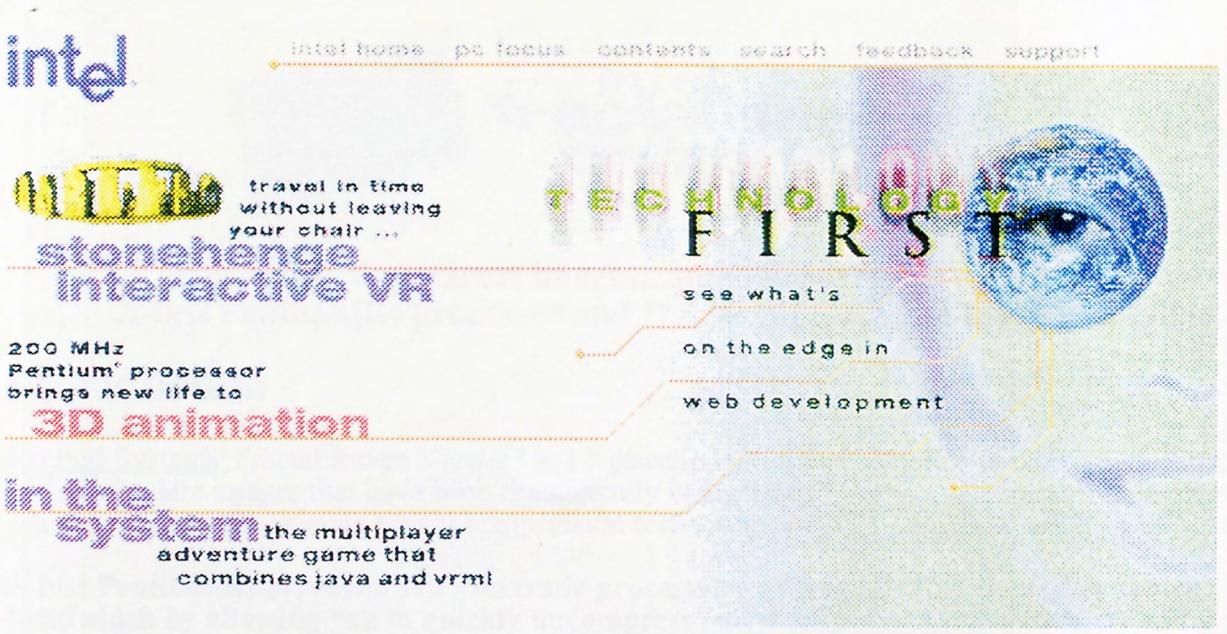


Great images...small file sizes? Explore Fractal Compression and see how it works!

New Pentium(R) Pro processor VRML with live3D extensions—Now compressed for faster download

If you are a designer or developer and you are looking for information on Intel products please refer to Info for Developers.

Trademark Information

Great images...small file sizes?
A fast Pentium(R) processor and fractal compression make it possible!

Introduction

Iterated Systems' Fractal Image Viewer* is a Netscape Navigator* 2.0 plug-in that allows you to view and manipulate images that have been dramatically compressed (we have encountered compression ratios exceeding 50:1) using fractal compression technologies.

A fast Pentium(R) processor lets you trade processor performance for precious network bandwidth by allowing you to quickly uncompress and manipulate these extremely compressed images.

Check it out!

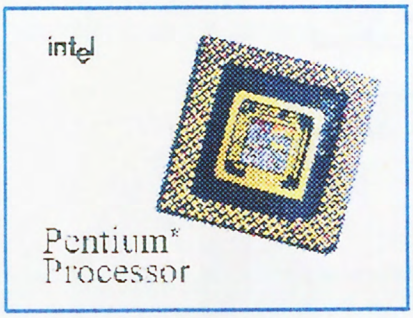
To see what it's like to use fractal compression, fire up your Pentium processor and get equipped with the Iterated Systems' Fractal Image Viewer plug-in available in the tools section.

We've assembled images from around the world of Intel in our gallery for you to check out. Enjoy the show!

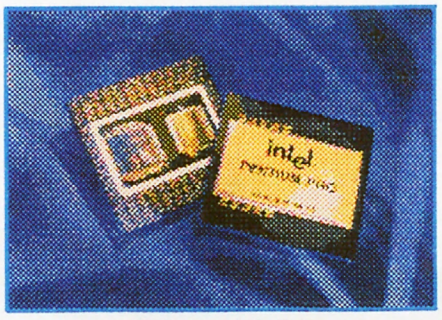
Trademark Information

fractal image compression gallery

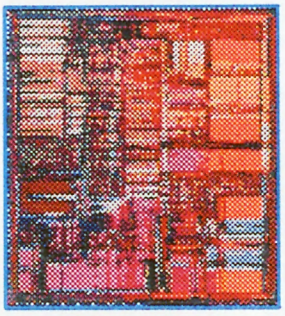
Don't forget to use the magnifying glass to zoom in, and the right mouse button to access other image manipulation features!



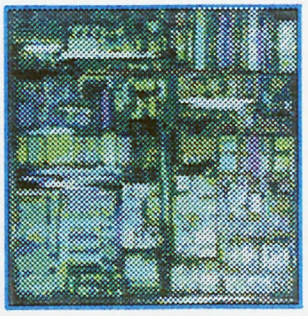
FIF size=64.8kb
BMP size=1.17Mb
Resolution=1280x960



FIF size=25.6kb
TIFF size=515kb
Resolution=673x469



FIF size=20kb
TIFF size=1.12Mb
Resolution=631x691

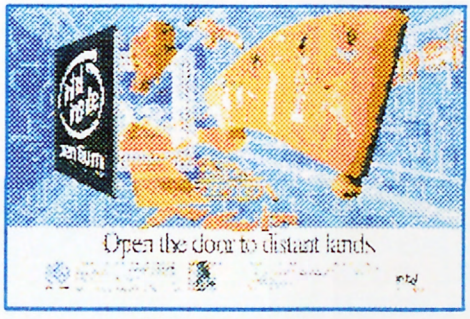


FIF size=20kb
TIFF size=816kb
Resolution=547x561

FIF size=21.1kb
TIFF size=708kb
Resolution=442x664

FIF size=67.4kb
TIFF size=3.05Mb
Resolution=1124x1670

FIF size=82.7kb
TIFF size=1.86Mb
Resolution=1217x787



FIF size=97.7kb
TIFF size=1.90Mb
Resolution=1211x792

FIF size=28.5kb
TIFF size=712kb
Resolution=457x685
Can you spot our CEO, Dr. Andrew S. Grove, in this 1968 shot?

Trademark information

Appendix 2

Fractal Demonstration

South Florida Ecosystem Program

Ecosystem project with fractal map

United States Geological Survey

WWW Home Page

Fractals

Information on Fractals and Fractal Viewing Software

USGS Catalog

Online ordering of USGS Mapping Products

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[*Information on Fractals* | ***Benefits of Fractals***
Fractal Viewer Software | *Fractal Gallery*]

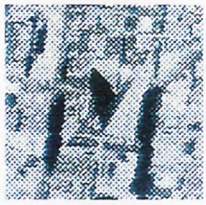
Fractal Compression vs. GIF or JPEG compression

Fractal Compression offers better compression than either GIF or JPEG. Images that are compressed with Fractal algorithms are better suited for an environment where size and download times are an issue. The table below lists the file sizes of a selection of images in different file formats. If you wish to compare image quality four formats are available for you to download.

How to View these files -

- **Targa (TGA):**
  Download the image to local disk and view the image with another application. Try LView if you do not already have a viewer.
- **GIF:**
  Your browser should support GIF images. If you would like to view them outside your browser, download the image to local disk and view the image with another application. Try LView if you do not already have a viewer.
- **JPEG:**
  If your browser does not support JPEG images, then download the image to local disk and view the image with another application. Try LView if you do not already have a viewer.
- **Fractal Image Format (FIF):**
  Download the Viewer and configure it as a helper application for your browser.

Click on the file size to view

Description	Targa (TGA)	GIF	JPEG	Fractal (FIF)
	3428k	513k	225k	151k
	8702k	1877k	634k	422k
	2904k	487k	95k	141k
	5164k	553k	217k	169k

Zooming Capabilities

Fractals are infinitely complex. Zooming in on a Fractally Compressed image just requires some recalculation on the client end so that there is no need to download another image to get a closer view. Here are some images that have already been magnified and compressed in the Fractal Image Format (FIF).

Click on the magnification size to view

2x 4x 8x 16x

2x 4x 8x

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3 1818 00242969 2