Bits of Geography

Michael F. Goodchild

Geographic information system

- System to acquire, store, transform, analyze, display, share, archive geographic information
- Geographic information
  - information about the specific characteristics of places on or near the Earth's surface
  - <***x***,***z***> where ***x*** is a location in space-time and ***z*** is some set of general properties

Directions	Distance
1:Start out going East on HENLEY ST towards WARREN ST.	0.1 miles (0.1 km)
2:Turn RIGHT onto WARREN ST.	0.0 miles (0.1 km)
3:Turn RIGHT onto CHELSEA ST.	0.0 miles (0.1 km)
4:CHELSEA ST becomes CHELSEA ST/CITY SQ.	0.1 miles (0.1 km)
5:Turn RIGHT onto CITY SQ/NEW RUTHERFORD AVE/SR-99 N.	0.0 miles (0.1 km)
6:Stay straight to go onto NEW RUTHERFORD AVE/SR-99 N.	0.2 miles (0.3 km)
7:Turn SLIGHT LEFT onto SR-99 N.	0.4 miles (0.6 km)
8:Turn SLIGHT LEFT onto SR-99 N/RUTHERFORD AVE.	0.1 miles (0.1 km)
9:Turn SLIGHT LEFT onto SR-99 N.	0.3 miles (0.4 km)
10:Turn SLIGHT LEFT onto SULLIVAN SQUARE OPAS.	0.4 miles (0.7 km)
11:Turn SLIGHT LEFT onto MYSTIC AVE.	0.7 miles (1.1 km)
12:MYSTIC AVE becomes MYSTIC AVE/SR-38 N.	1.2 miles (2.0 km)
13:Turn LEFT onto HARVARD ST.	0.6 miles (1.0 km)
14:HARVARD ST becomes WARNER ST.	0.2 miles (0.3 km)
15:Turn RIGHT onto POWDER HOUSE SQ.	0.1 miles (0.1 km)
16:Turn RIGHT onto BROADWAY.	1.0 miles (1.6 km)
17:Turn LEFT onto ALEWIFE BROOK PKWY/SR-16.	0.4 miles (0.7 km)
18:ALEWIFE BROOK PKWY/SR-16 becomes ALEWIFE BROOK PKWY/SR-16/US-3.	0.4 miles (0.7 km)
19:Take CONCORD TURNPIKE/SR-2 W.	4.7 miles (7.6 km)
20:Take the WALTHAM ST. exit, exit number 54B, towards LEXINGTON.	0.2 miles (0.3 km)
21:Merge onto WALTHAM ST.	1.9 miles (3.0 km)
22:Turn RIGHT onto MASSACHUSETTS AVE/MASS AVE/SR-225.	0.0 miles (0.0 km)
Total Distance:	12.9 miles (20.8 km)
Estimated Time:	24 minutes

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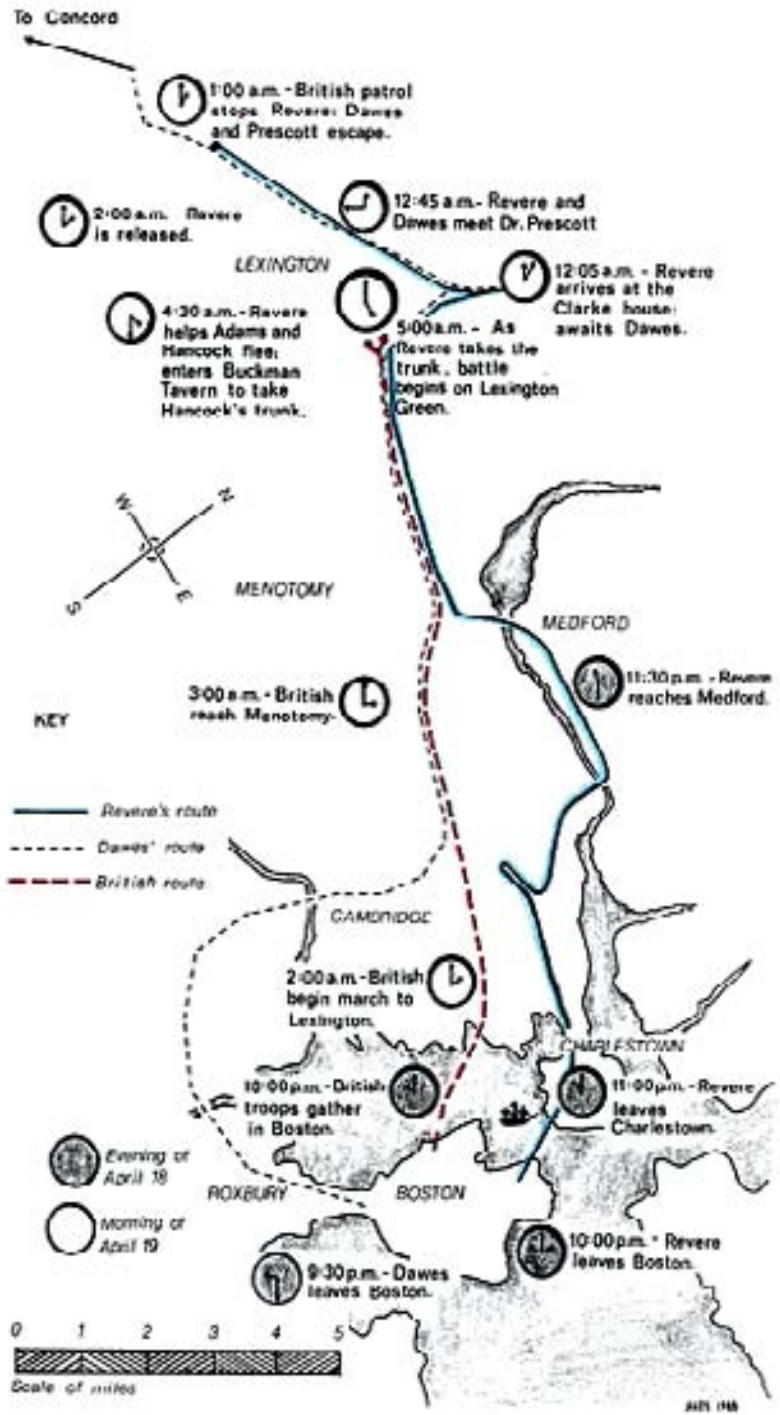
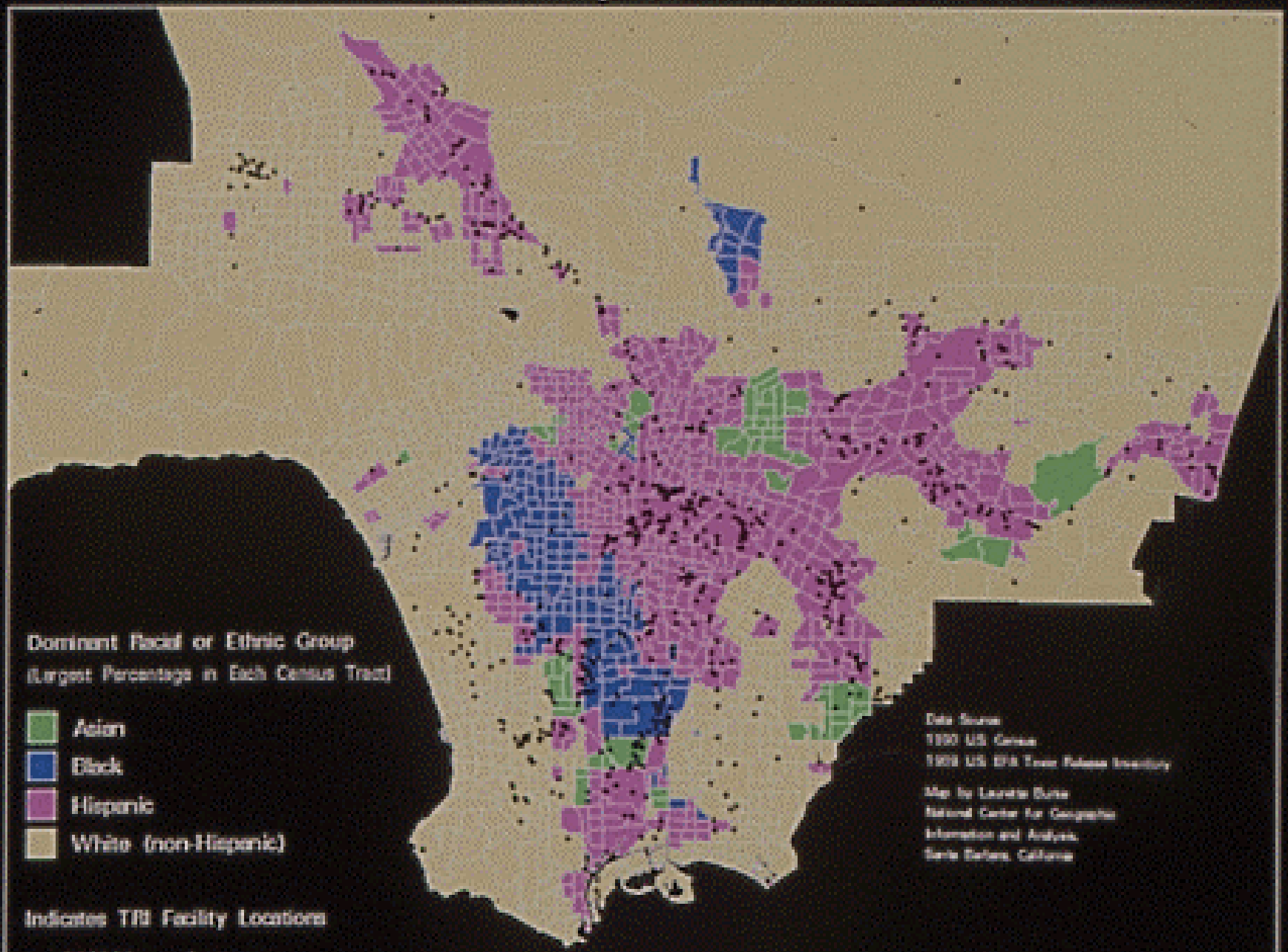
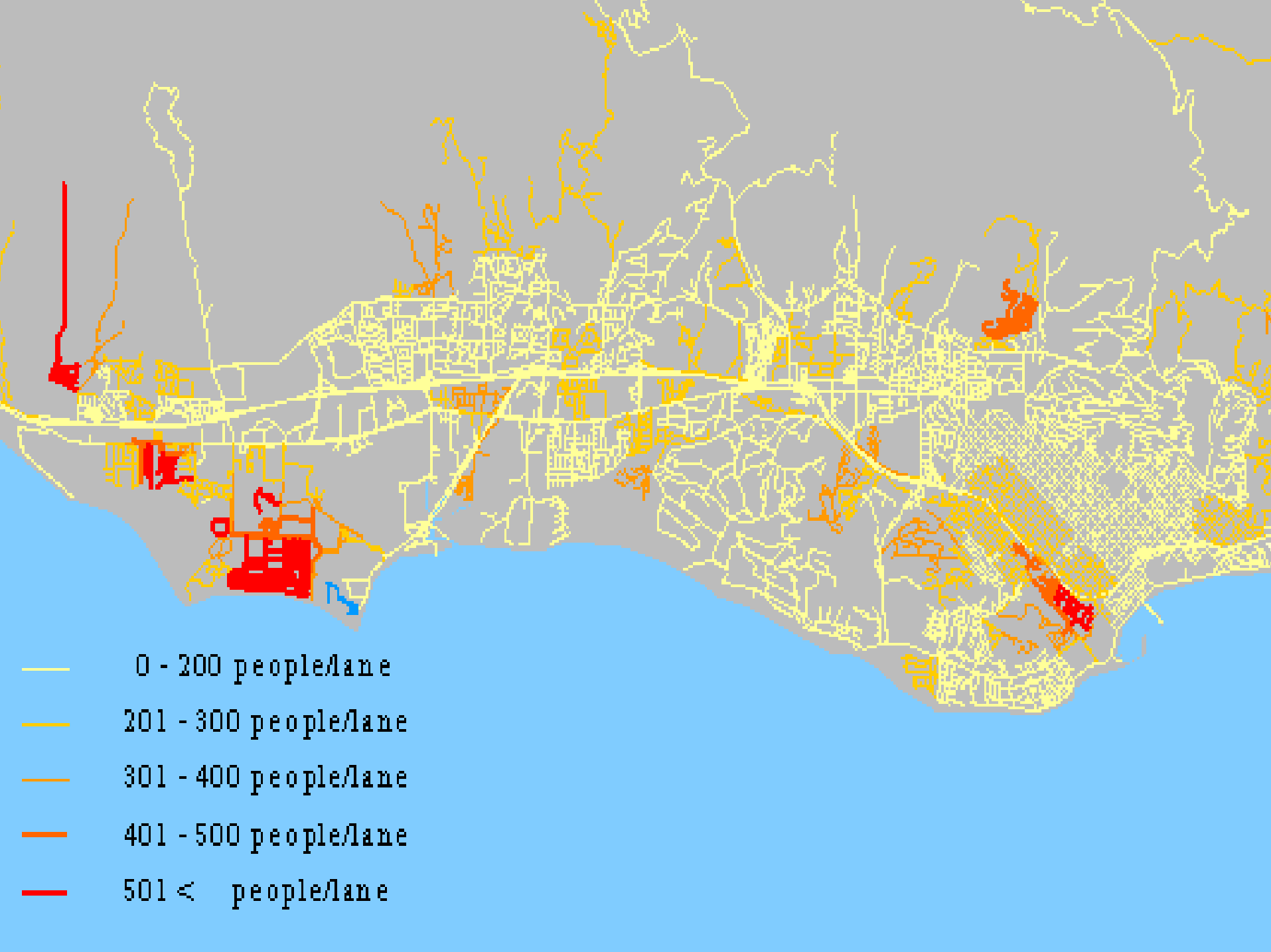


Race, Ethnicity and TRI Facilities




0 - 200 people/lane
201 - 300 people/lane
301 - 400 people/lane
401 - 500 people/lane
501 < people/lane

PASS

File View Tools Window Help

List View

WorkCtr | Location | Visit | M067124

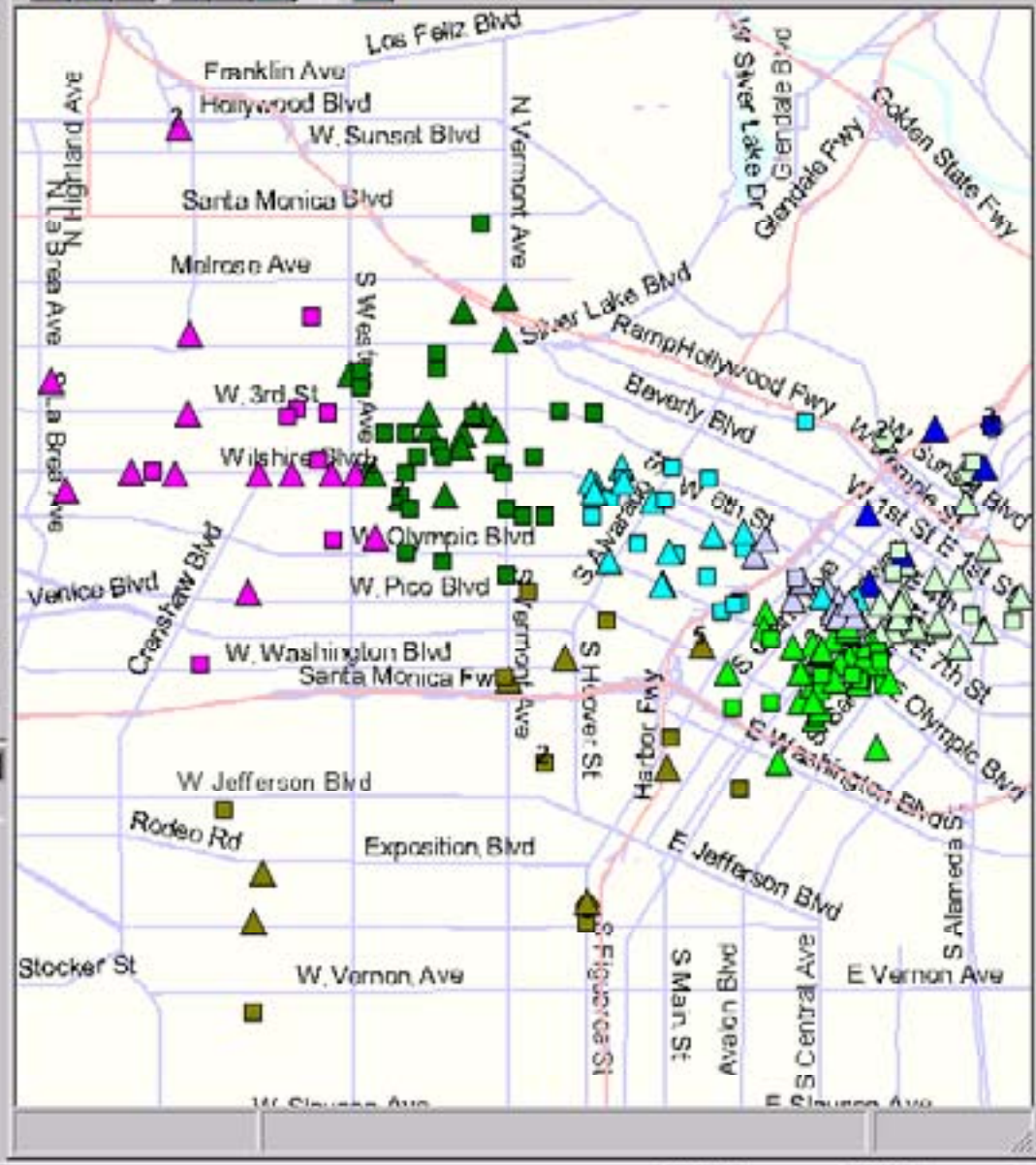
Name	Address	Units	Hrs/Mth	M	Type
1130 VERMONT	1130 VERMONT S	1	0.9	7	HY
625 NEW HAMPSHIRE	625 NEW HAMPSHII	1	0.9	2	HY
3611 WILSHIRE	3611 WILSHIRE BLV	1	0.6	6	HY
114 OXFORD	114 OXFORD S	1	0.8	3	HY
3099 OLYMPIC CAL KOREA B	3099 OLYMPIC BLVI	1	0.9	5	HY
542 MARIPOSA GORDON CHI	542 MARIPOSA S	1	0.8	5	HY
140 MARIPOSA AVE	140 MARIPOSA AVE	1	0.9	9	HY
209 MARIPOSA S	209 MARIPOSA S	1	0.8	5	HY
2930 FRANCIS	2930 FRANCIS	1	0.9	4	HY
248 OCCIDENTAL	248 OCCIDENTAL	1	0.9	3	HY
601 WESTMORELAND	601 WESTMORELAI	1	0.7	4	HY
303 COMMONWEALTH	303 COMMONWEAL	1	0.9	9	HY
2830 FRANCIS	2830 FRANCIS	1	0.9	7	HY
187 OXFORD OXFORD VILLA	187 OXFORD	1	0.9	8	HY
601 ARDMORE PUBLIC COUI	601 ARDMORE AVE	1	0.7	5	HY
3535 SIXTH ST.	3535 W SIXTH	1	0.7	5	HY
1052 MARIPUSA AVE	1052 S MARIPUSA	1	1.0	0	HY
128 MARIPOSA AV S	128 MARIPOSA AV S	1	0.8	4	HY
449 KINGSLEY BLDG	449 KINGSLEY DRIV	2	1.9	2	HY
445 HOBART	445 HOBART	2	1.8	6	HY
350 CATALINA BLDG	350 CATALINA STRE	1	0.9	6	HY
3500 EIGHTH STREET BLDG	3500 EIGHTH STRE	1	0.9	5	HY
3020 WILSHIRE BLDG	3020 WILSHIRE BLV	2	0.0	0	HY

Chart

Chart All | Dollars | Units | Hours | C1

Map

Show selected only



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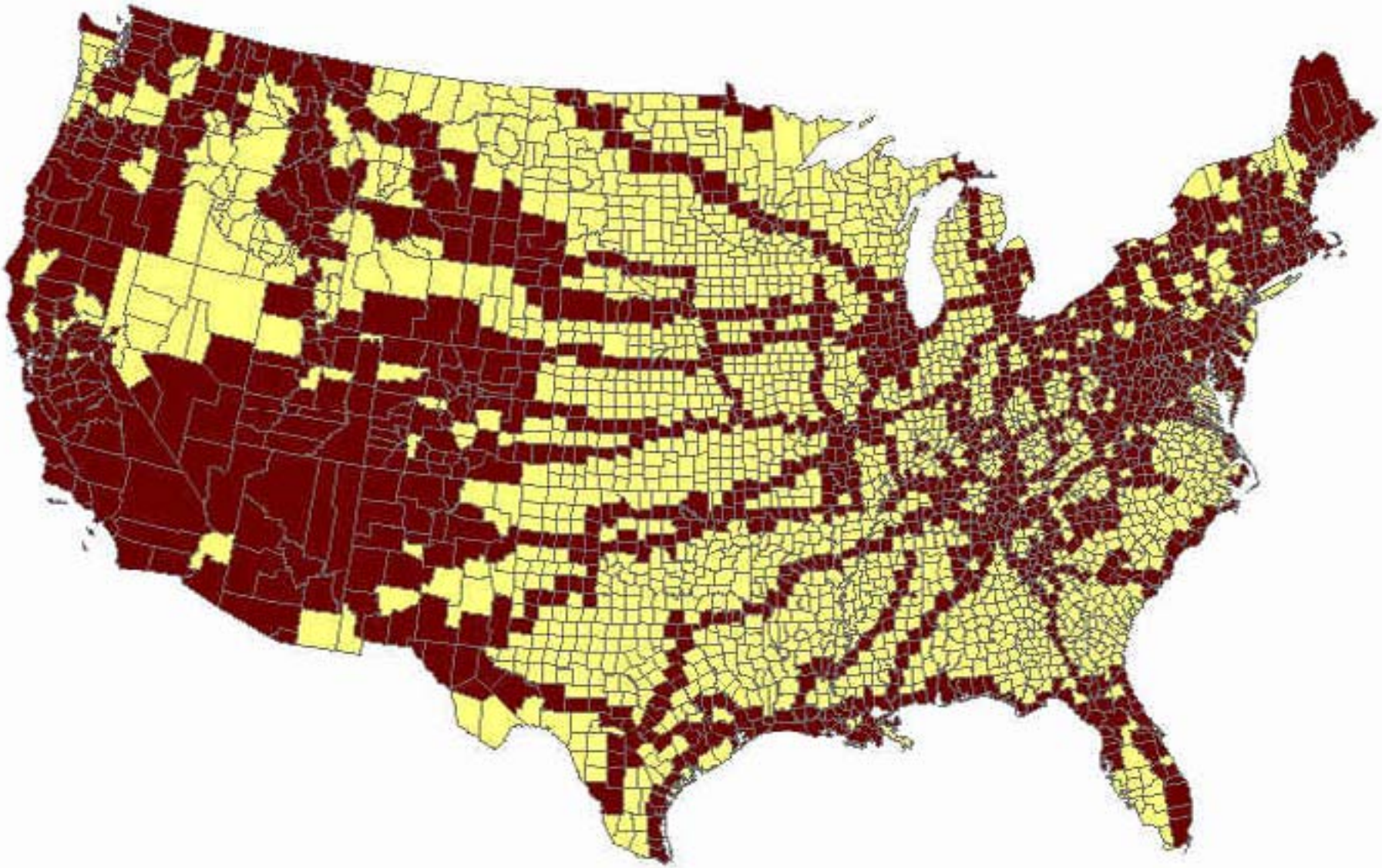
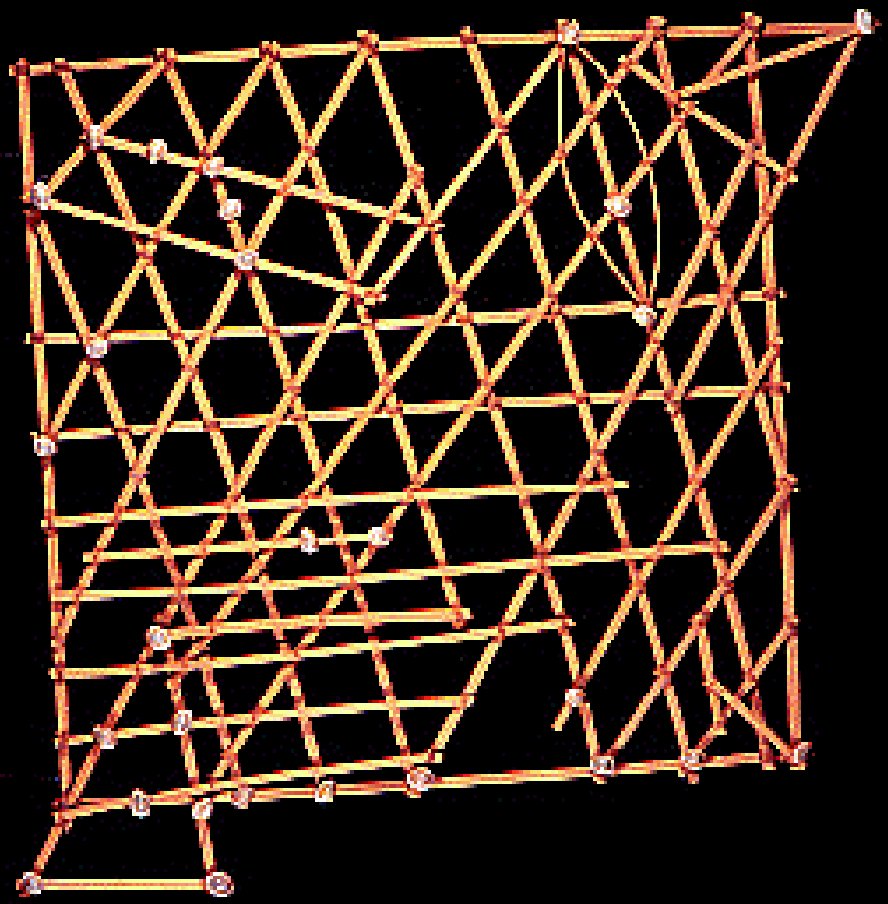
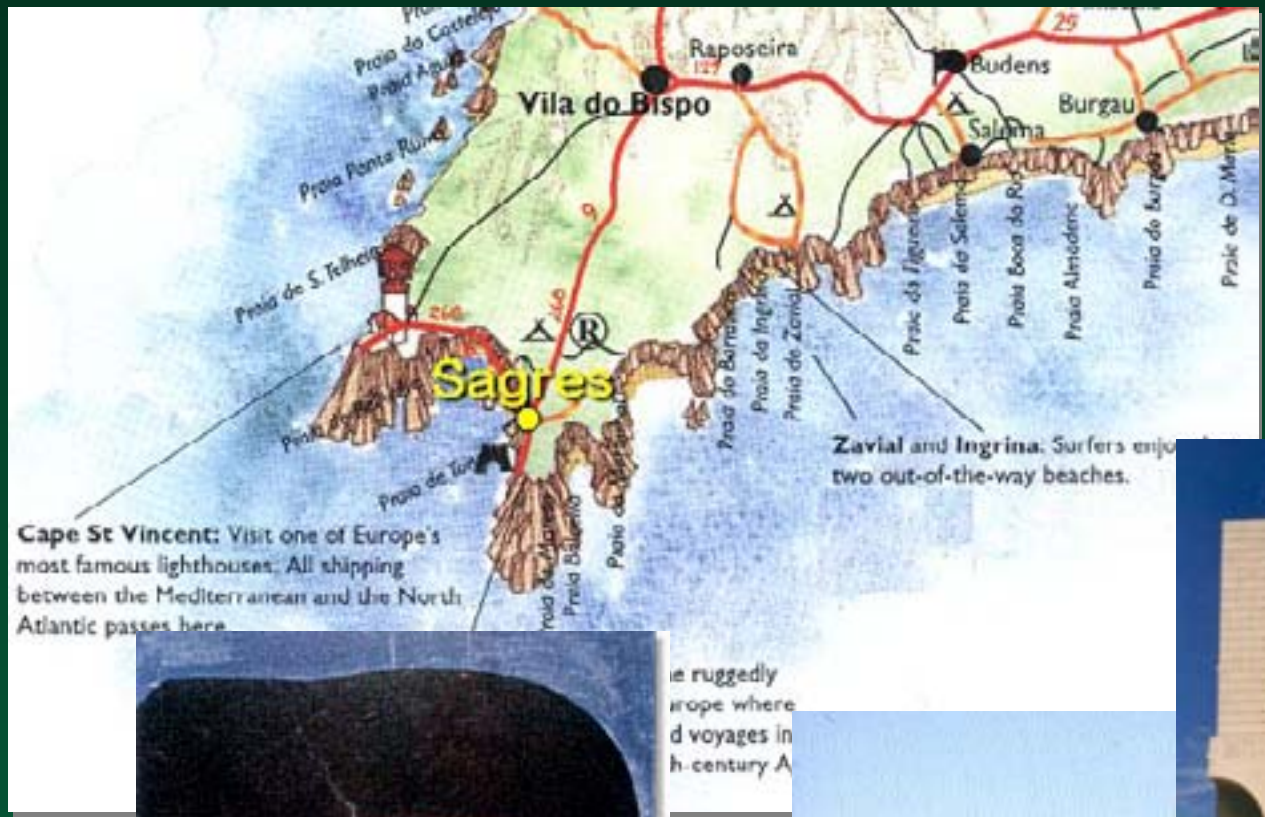


Standard coding schemes

- Music: MIDI, MP3
- Images: JPEG, TIFF, GIF
- FAX: CCITT
- Text: ASCII
- Planet Earth: ?




Raposeira
Vila do Bispo
Budens
Burgau
Salema
Sagres
Cape St Vincent: Visit one of Europe's most famous lighthouses. All shipping between the Mediterranean and the North Atlantic passes here.
Zavial and Ingrina. Surfers enjo
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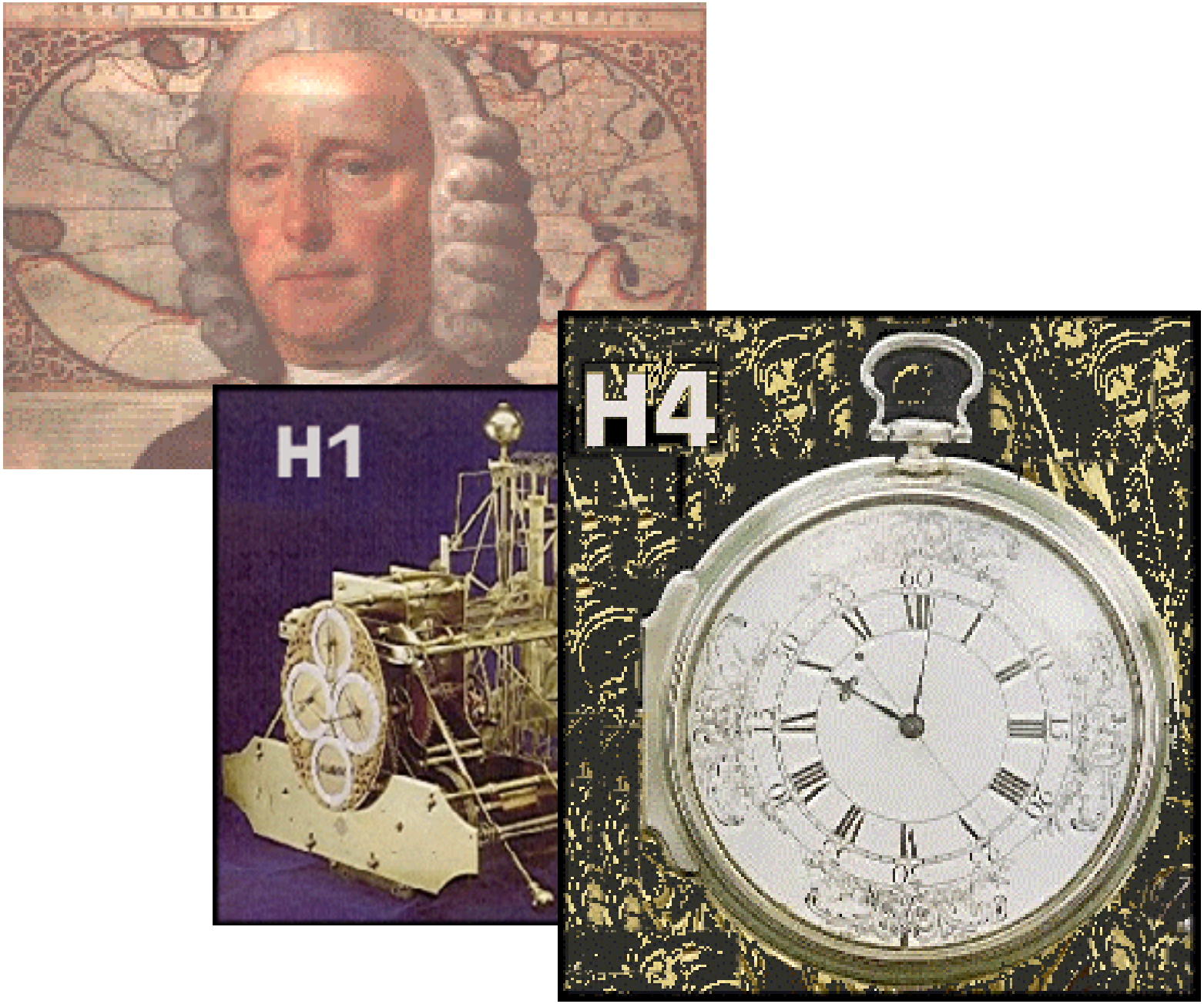
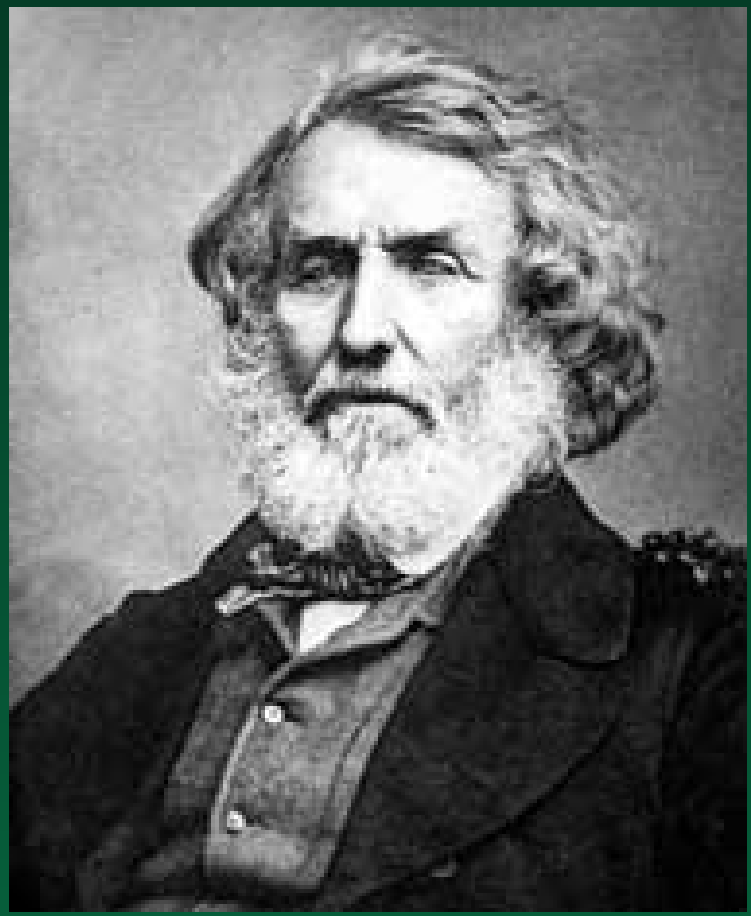
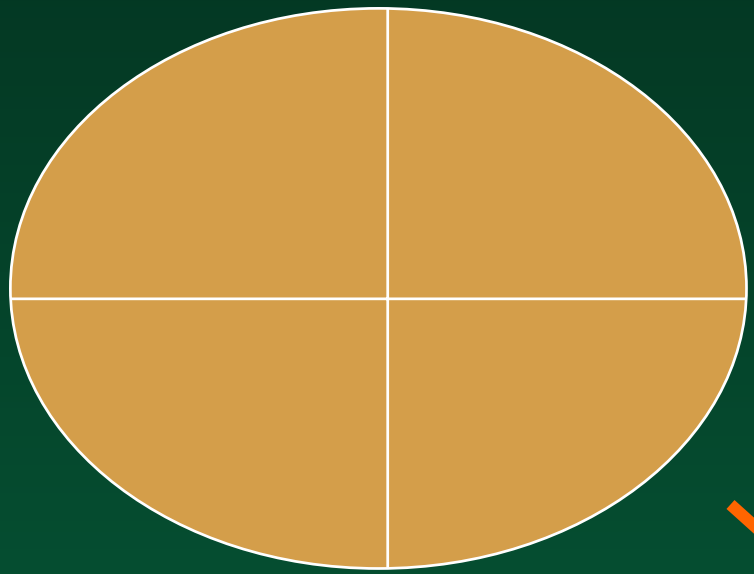

H1
H4





Clarke Ellipsoid of 1866

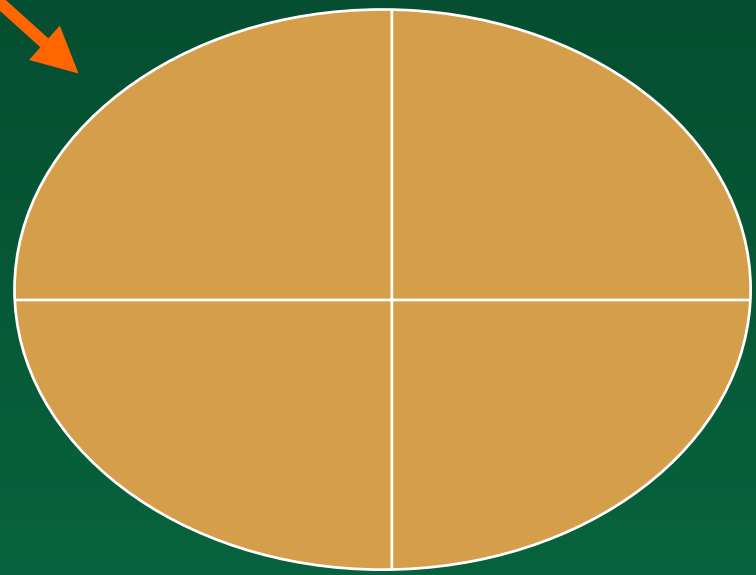
a = 6378206 m

1/*f* = 294.98

World Geodetic System of 1984

a = 6378137 m

1/*f* = 298.26



Trimble Placer GPS 400
Northing
770
760
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lan GPS Companion for Visor
Northing
770
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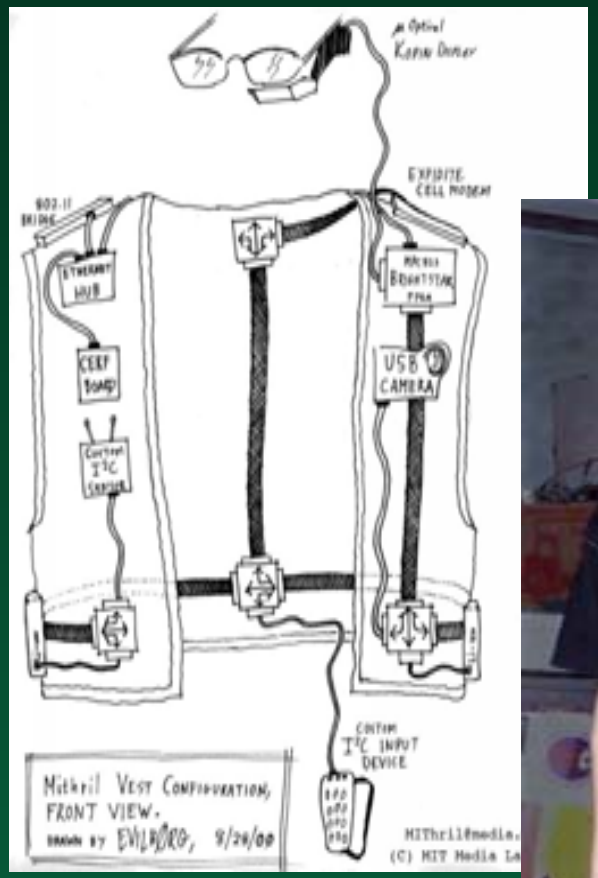
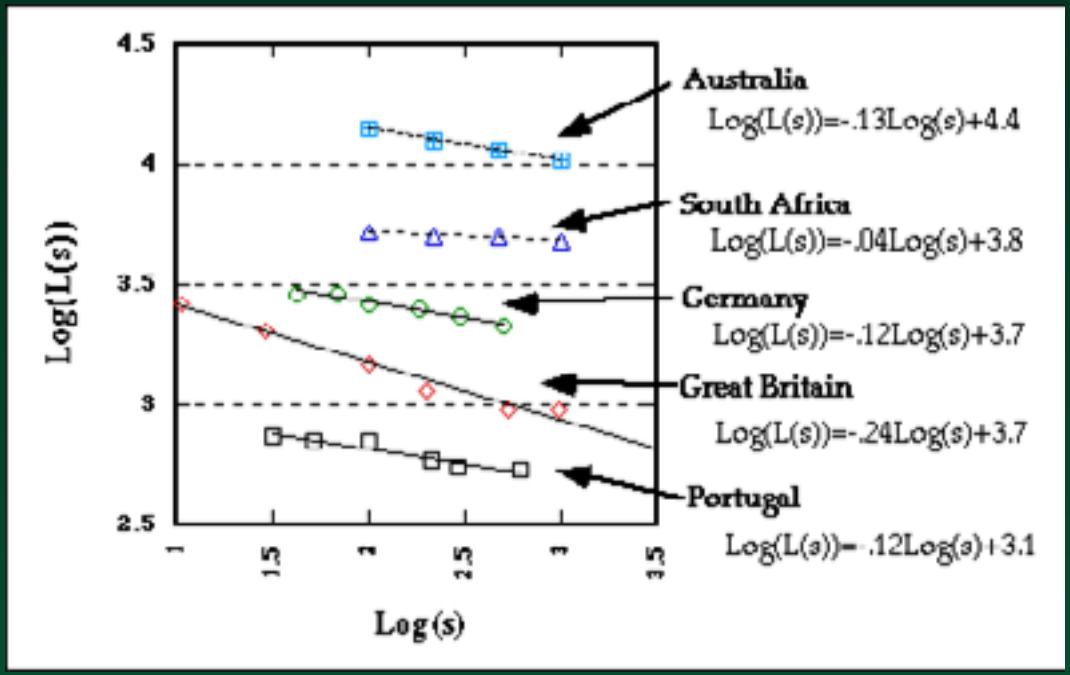
Easting (m)


Optional
Kopin Driver
EXPRESS CELL MODEM
802.11 BRIDGE
ETHERNET HUB
MICRO BRIGHTSTAR PDA
CERF BOARD
USB CAMERA
Custom I²C Sensor
CUSTOM I²C INPUT DEVICE
Mithril VEST CONFIGURATION, FRONT VIEW.
DRAWN BY EVILROBO, 9/20/00
MIThril@media.
(C) MIT Media La


MIThril
Rich DeVaul
Steve Schwartz
Sandy Pentland
borglab
MIT Media Lab

Tobler's First Law of Geography

- All things are related, but nearby things are more related than distant things
  - Tobler, W.R., 1970. A computer movie simulating urban growth in the Detroit region. *Economic Geography* 46: 234-240.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South Africa
Log(L(s))=-.04Log(s)+3.8
Germany
Log(L(s))=-.12Log(s)+3.7
Great Britain
Log(L(s))=-.24Log(s)+3.7
Portugal
Log(L(s))= .12Log(s) + 3.1
Log(L(s))
Log (s)
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4
3.5
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2.5
1
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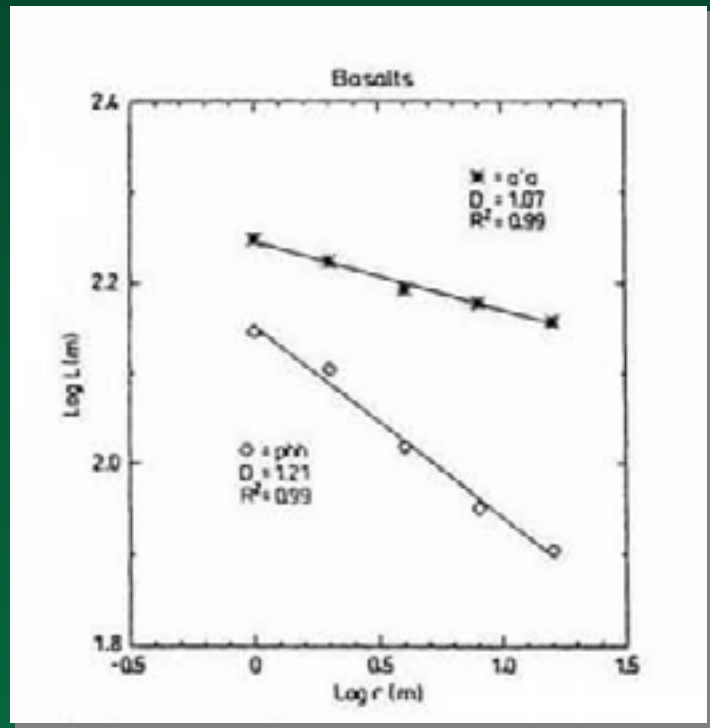
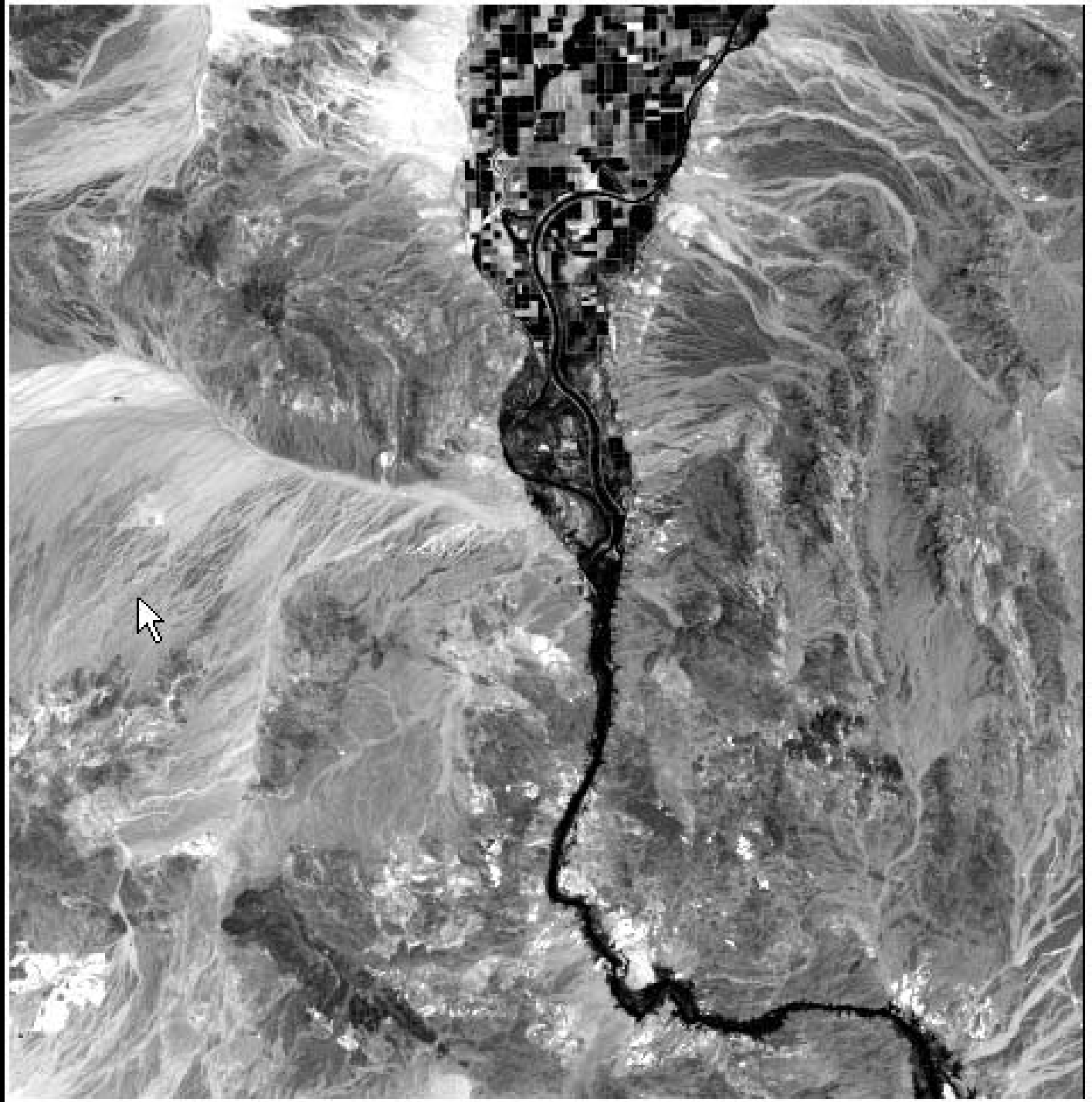
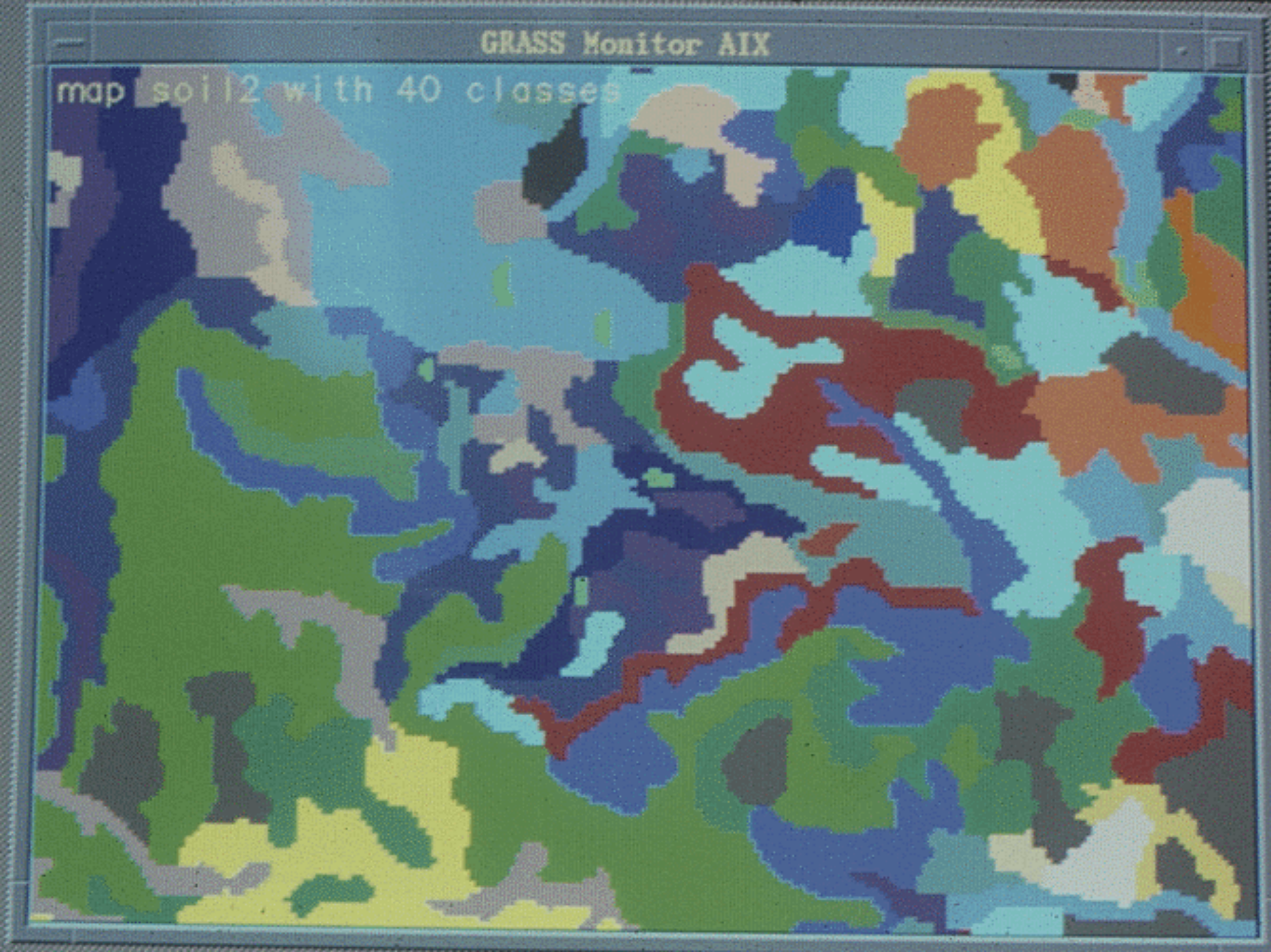
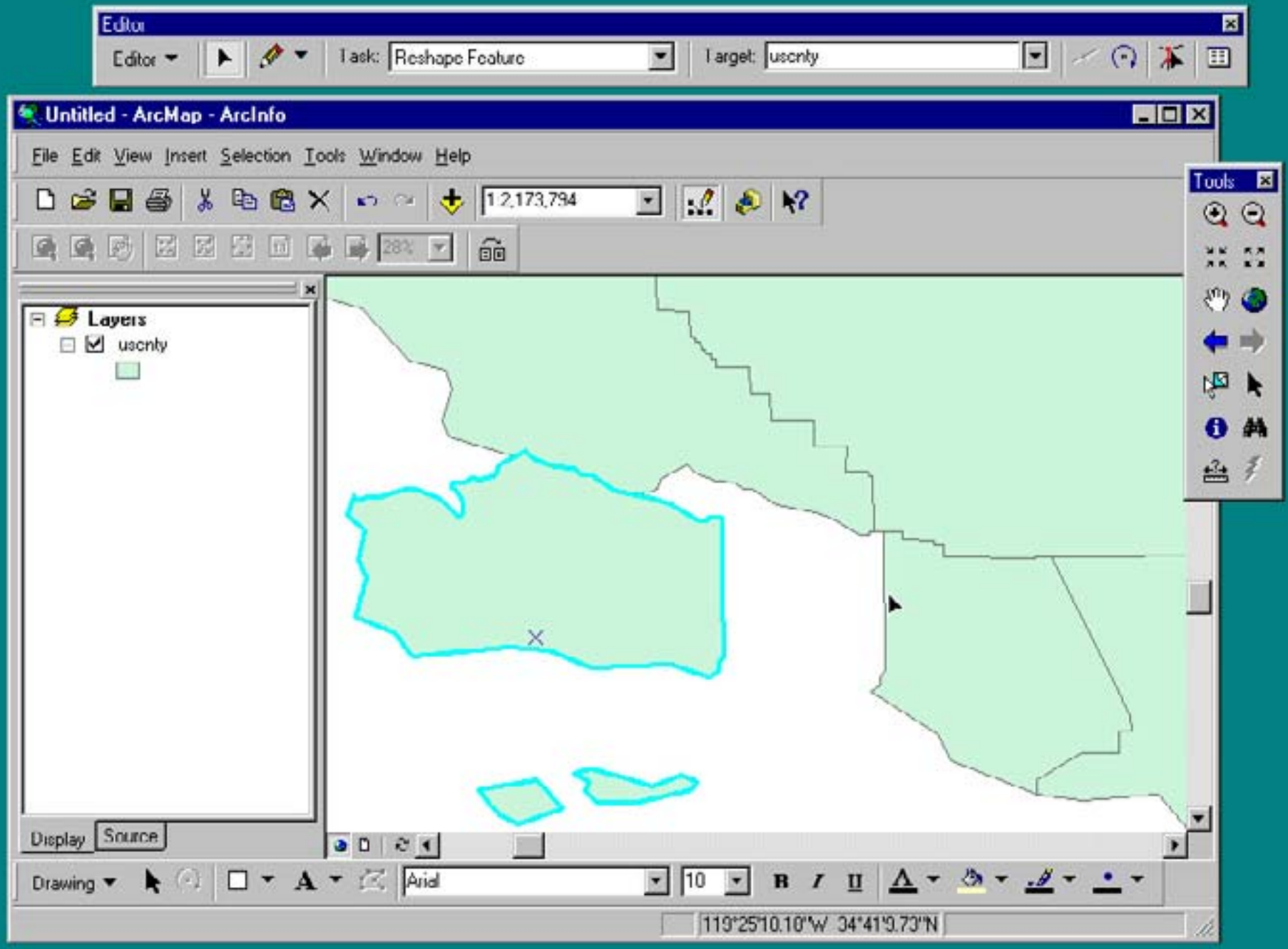

Basalts
D = 1.07
R² = 0.99
D = 1.21
R² = 0.99
Log L (m)
Log r (m)
2.4
2.2
2.0
1.8
-0.5
0
0.5
1.0
1.5


LVL=12,SOLID,WT=2,LC=SOL,CON,CO=3
Identify known point on digitizer
DIGITIZER SETUP (RESET TO EXIT)
(1) mge>
MGE
Fit
Select Feature
Set Feature
Make Feature
Digitize Mode
Define Attr
Auto loader
Geo db locate
Geo index locate
Display Mgr
Exit
Feature Code
Define
Keyin
Secondary Long Lat
East North
Secondary East North
Geocentric
Second Geocentric
Geodesic
Scale Factors
BROMLEY LN
HOPKINS AVE
MAIN ST




GRASS Monitor AIX
map soil2 with 40 classes


Editor
Editor
Task:
Reshape Feature
Target:
uscnty
Untitled - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
1:2,173,794
Tools
Layers
uscnty
Display
Source
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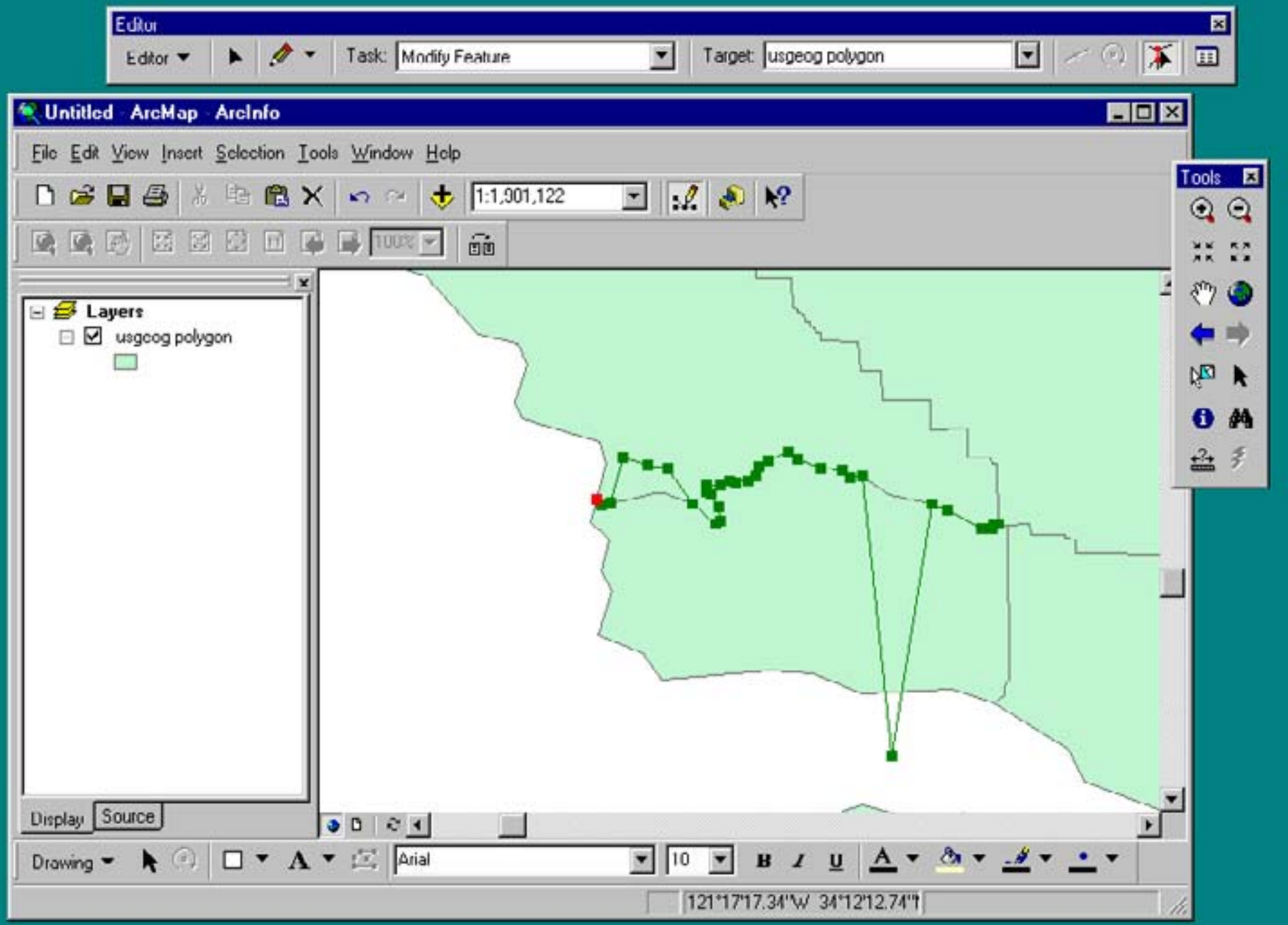
Arial
10
119°25'10.10"W 34°41'0.73"N


Editor
Editor
Task: Modify Feature
Target: usgeog polygon
Untitled - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
1:1,901,122
Tools
Layers
usgeog polygon
Display
Source
Drawing
Arial
10
121°17'17.34"W 34°12'12.74"N


display.june.stp - Display
File View Map GPS Comm Window Help
A B C D E F G H I
Ready
Time: 1.00
241697.0
3814757.1
Zone 11
no gps
no gps
CLARENCE WARD MEMC
0 - 0
0 - 0
Start
fwy-ce.bmp - Paint
C:\Vital
display.june.stp - Dis...
13:19

A grand challenge of GIS

- To create useful, comprehensive digital representations of the enormous complexity of the Earth's surface in the limited space of a digital store, using a binary alphabet

“Imagine, for example, a young child going to a Digital Earth exhibit at a local museum. After donning a head-mounted display, she sees Earth as it appears from space. Using a data glove, she zooms in, using higher and higher levels of resolution, to see continents, then regions, countries, cities, and finally individual houses, trees, and other natural and man-made objects. Having found an area of the planet she is interested in exploring, she takes the equivalent of a ‘magic carpet ride’ through a 3-D visualization of the terrain.”

Is Digital Earth feasible?

- 500,000,000 sq km
  - 5 million at 10km resolution
  - 500,000,000,000,000 at 1m resolution

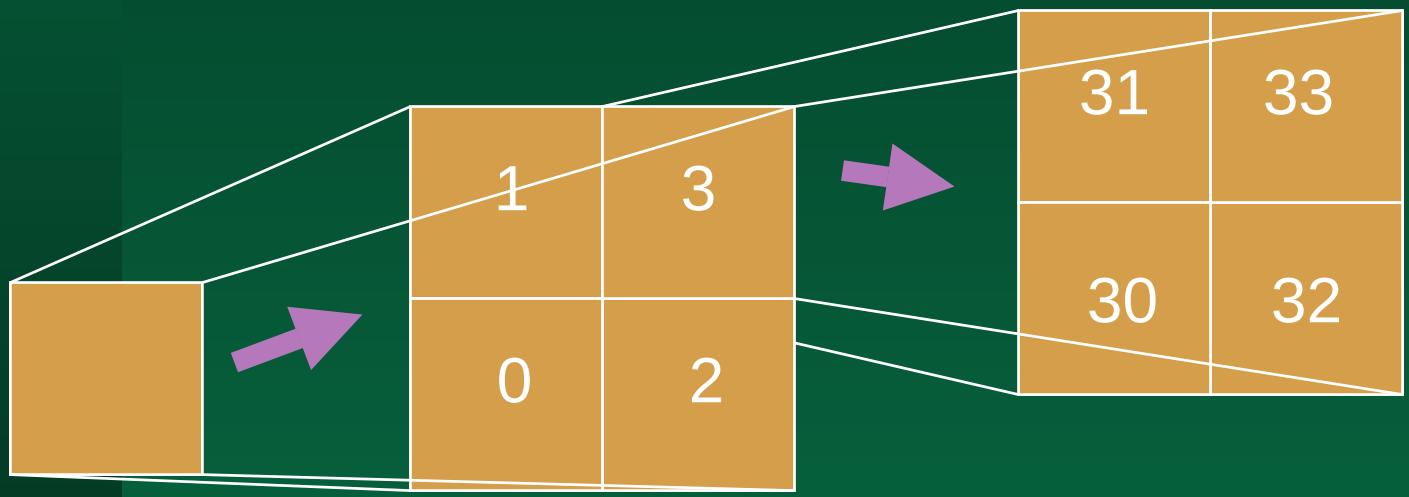
500,000,000,000,000
500,000,000 seconds
138,888 hours
69.4 working years

The LS ratio

- Computer screen - 1000
- Digital camera - 1500
- Remotely sensed scene - 3000
- Paper map - 5000
- Dimensionless
- $Log_{10}L/S$ in range 3-4
- Human eye - 10,000

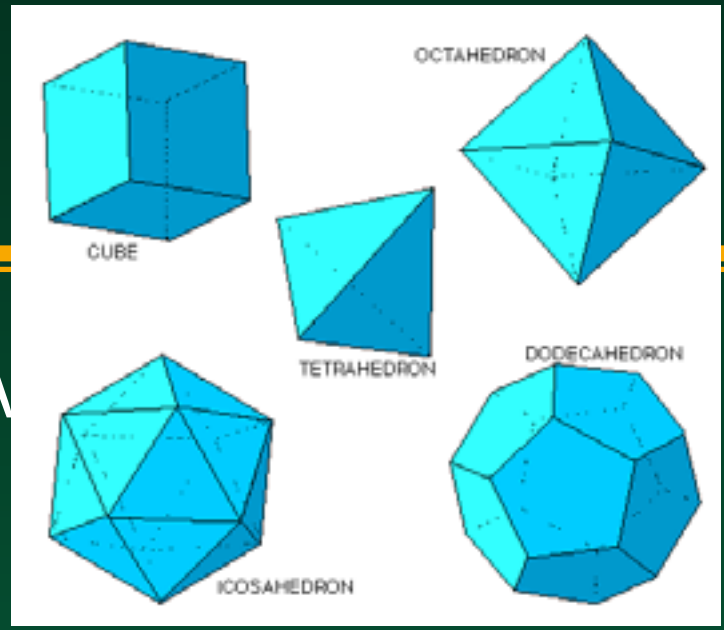
The quadtree

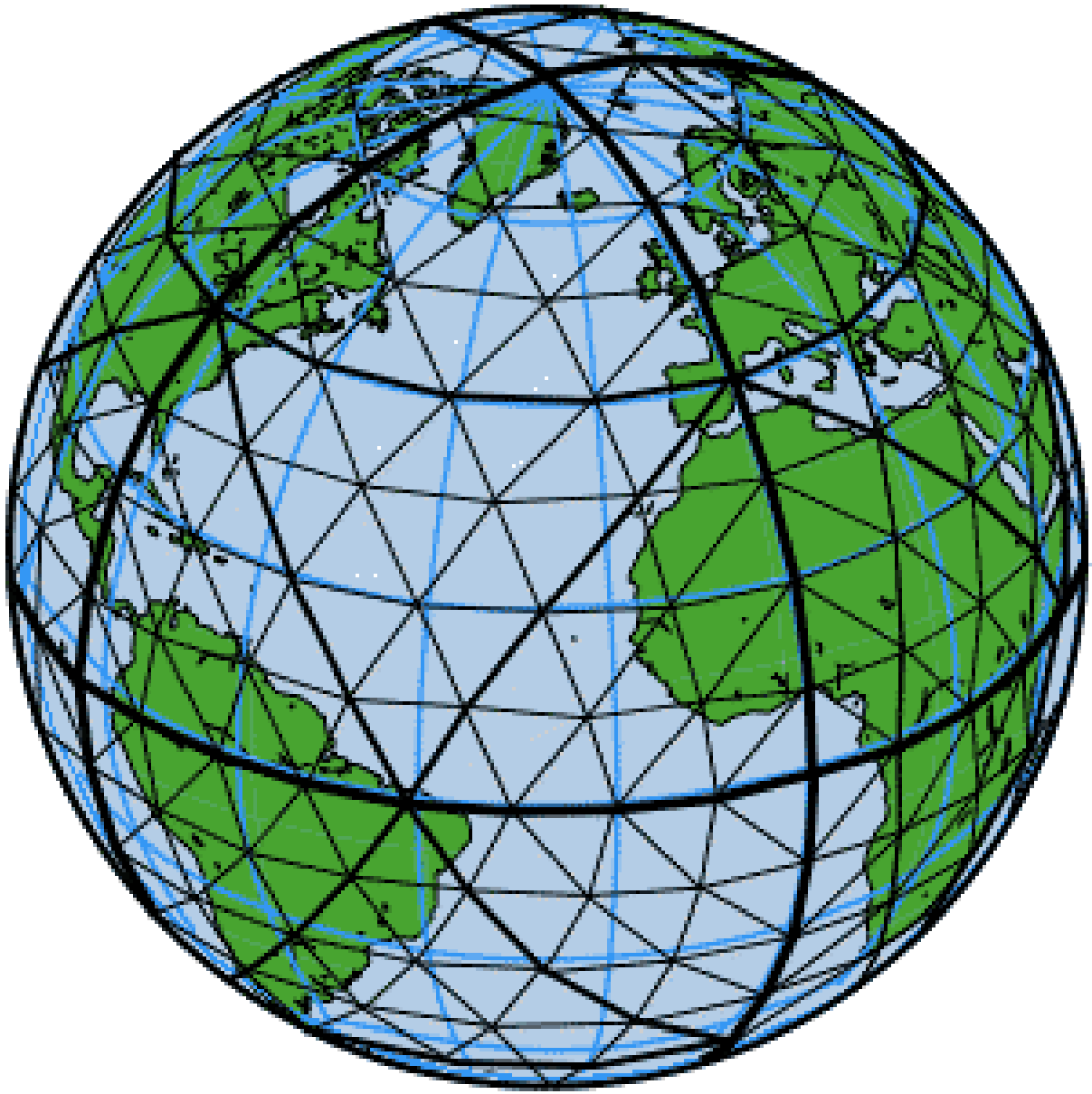
- Recursive subdivision
  - variable depth depending on local detail

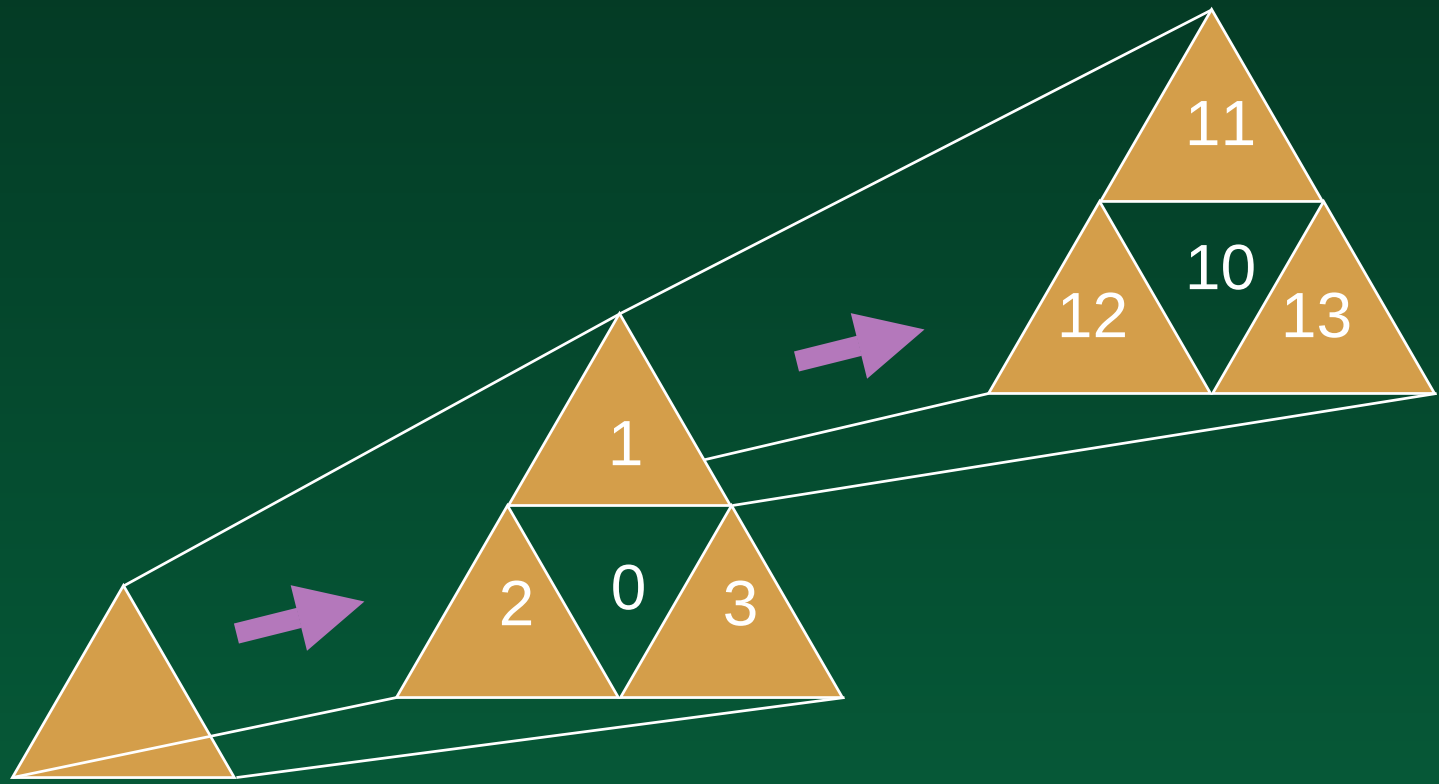


Grids on the globe

- Impossible to tile a curv
  squares
- Five Platonic solids
  - tetrahedron: 4 triangles
  - cube: 6 squares
  - octahedron: 8 triangles
  - dodecahedron: 12 pentagons
  - icosahedron: 20 triangles







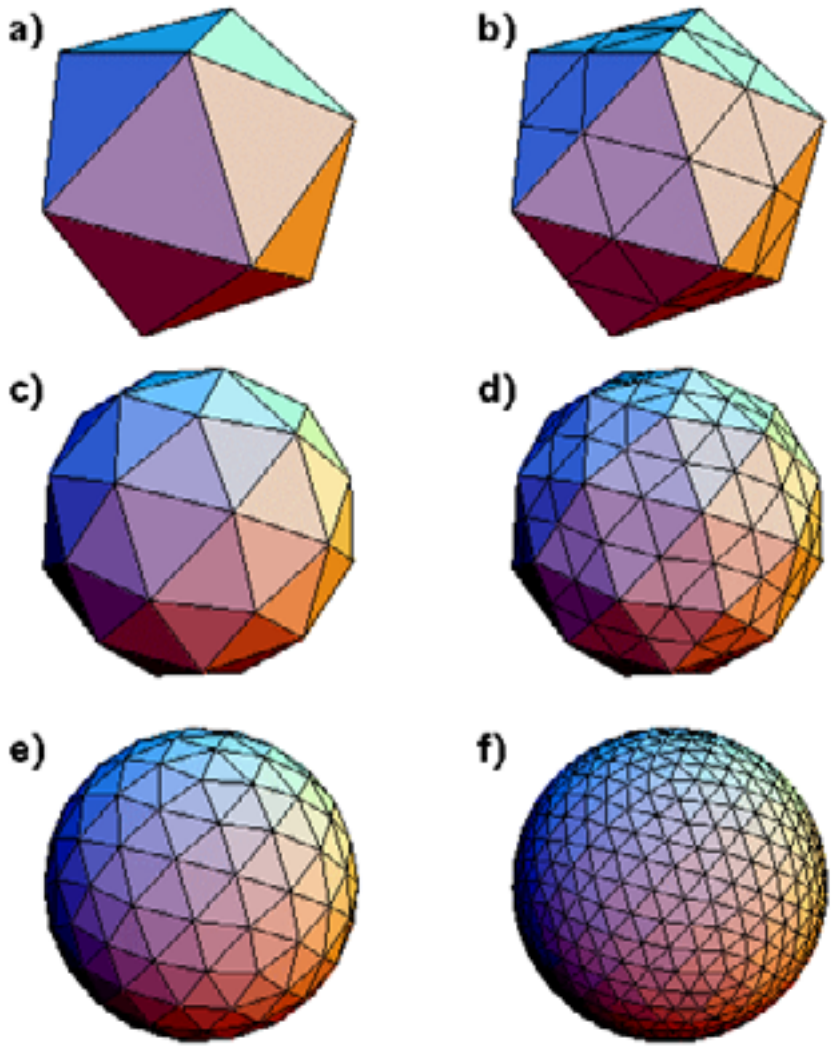
Octahedron: 1 base 8 digit plus unlimited base 4 digits

Discrete global grid based on the Icosahedron (20 triangles, 1:4 recursive subdivision)

Ross Heikes and David Randall, Colorado State University

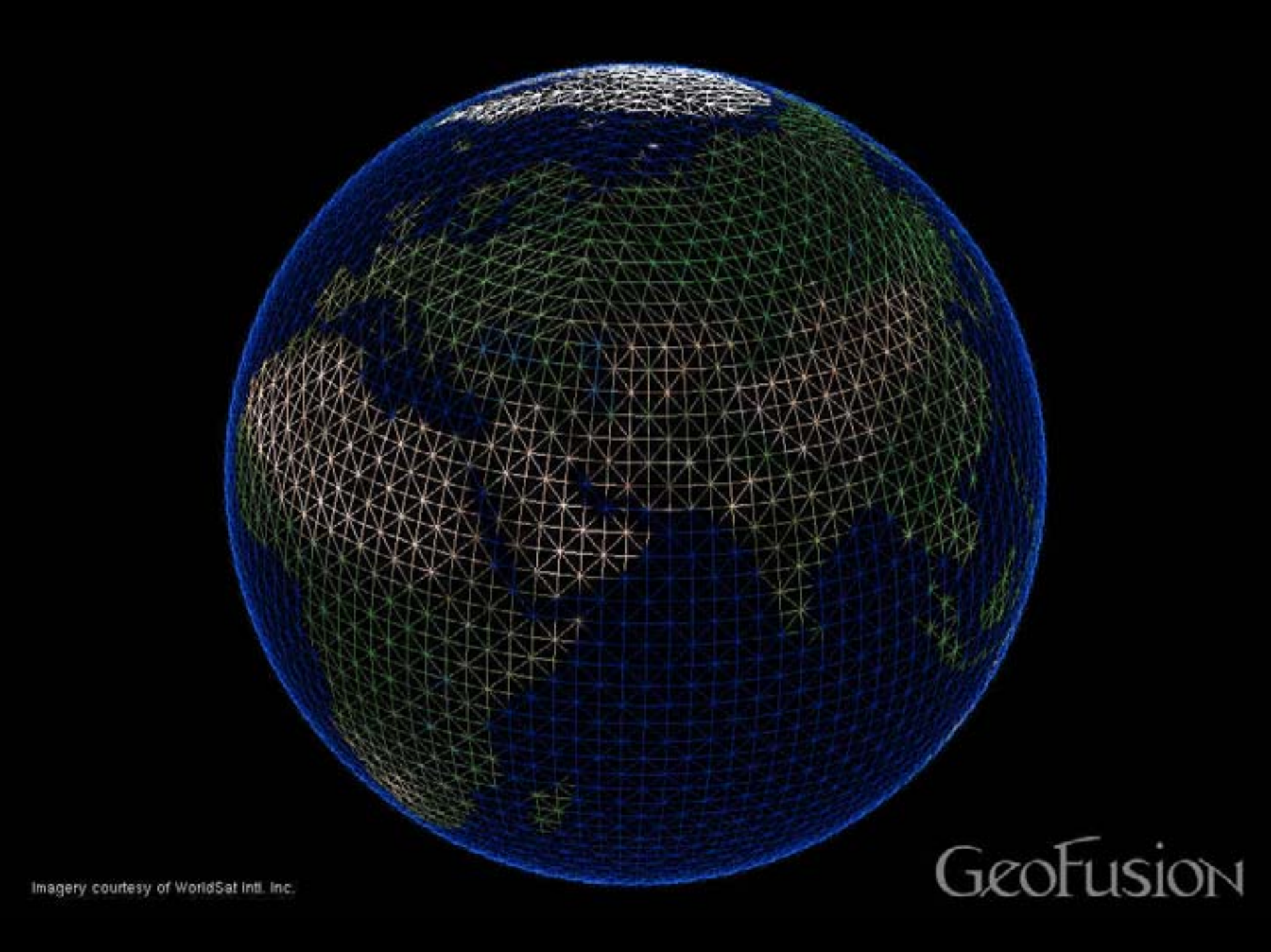
Construction of a simple Icosahedral grid

a) Suppose we have an icosahedron inscribed inside of a unit sphere.
b) Bisecting each edge forms 30 new vertices, and partitions each equilateral face into four pieces.
c) Project the new vertices onto the unit sphere.
d) Bisect and partition again.
e) Project again.
f) And so on.... The result is a sequence of polyhedrons that increasingly approximate the sphere.



Comparison of Criteria for the Assessment of Global Grids

Criteria in Goodchild (1994)	*Criteria in Kimerling et al. (1999) (Goodchild's Numbers given in parentheses)*
1. Each area contains one point	Areal cells constitute a complete tiling of the globe, exhaustively covering the globe without overlapping. (3,7)
2. Areas are equal in size	Areal cells have equal areas. This minimizes the confounding effects of area variation in analysis, and provides equal probabilities for sampling designs. (2)
3. Areas exhaustively cover the domain	Areal cells have the same topology (same number of edges and vertices). (9, 14)
4. Areas are equal in shape	Areal cells have the same shape. ideally a regular spherical polygon with edges that are great circles. (4)
5. Points form a hierarchy preserving some property for m < n points	Areal cells are compact. (10)
6. Areas form a hierarchy preserving some property for m < n areas	Edges of cells are straight in a projection. (8)
7. The domain is the globe (sphere, spheroid)	The midpoint of an arc connecting two adjacent cells coincides with the midpoint of the edge between the two cells.
8. Edges of areas are straight on some projection	The points and areal cells of the various resolution grids which constitute the grid system form a hierarchy which displays a high degree of regularity. (5,6)
9. Areas have the same number of edges	A single areal cell contains only one grid reference point.(1)
10. Areas are compact	Grid reference points are maximally central within areal cells. (11)
11. Points are maximally central within areas	Grid reference points are equidistant from their neighbors. (12)
12. Points are equidistant	Grid reference points and areal cells display regularities and other properties which allow them to be addressed in an efficient manner.
13. Edges are areas of equal length	The grid system has a simple relationship to latitude and longitude.
14. Addresses of points and areas are regular and reflect other properties	The grid system contains grids of any arbitrary defined spatial resolution. (5,6)


Imagery courtesy of WorldSat Intl. Inc.
GeoFusion

Imagery courtesy of WorldSat Intl. Inc.

GeoFusion