Map and GPS Fundamentals

Or, I'm lost. How do I find my way back to the trailhead?

Seminar Objectives

- *Read topographic maps*
- *Understand geographic coordinate system (Lat, Lon)*
- *Plot Lat/Lon coordinates on maps*
- *Read Lat/Lon coordinates off maps*
- *See demo of Google Earth*
- Understand UTM coordinate system
- Plot UTM coordinates maps
- Read UTM coordinates off maps
- See demo of National Geographic TOPO! Software
- Learn how to download tracks to your GPS
- Begin geocaching competition

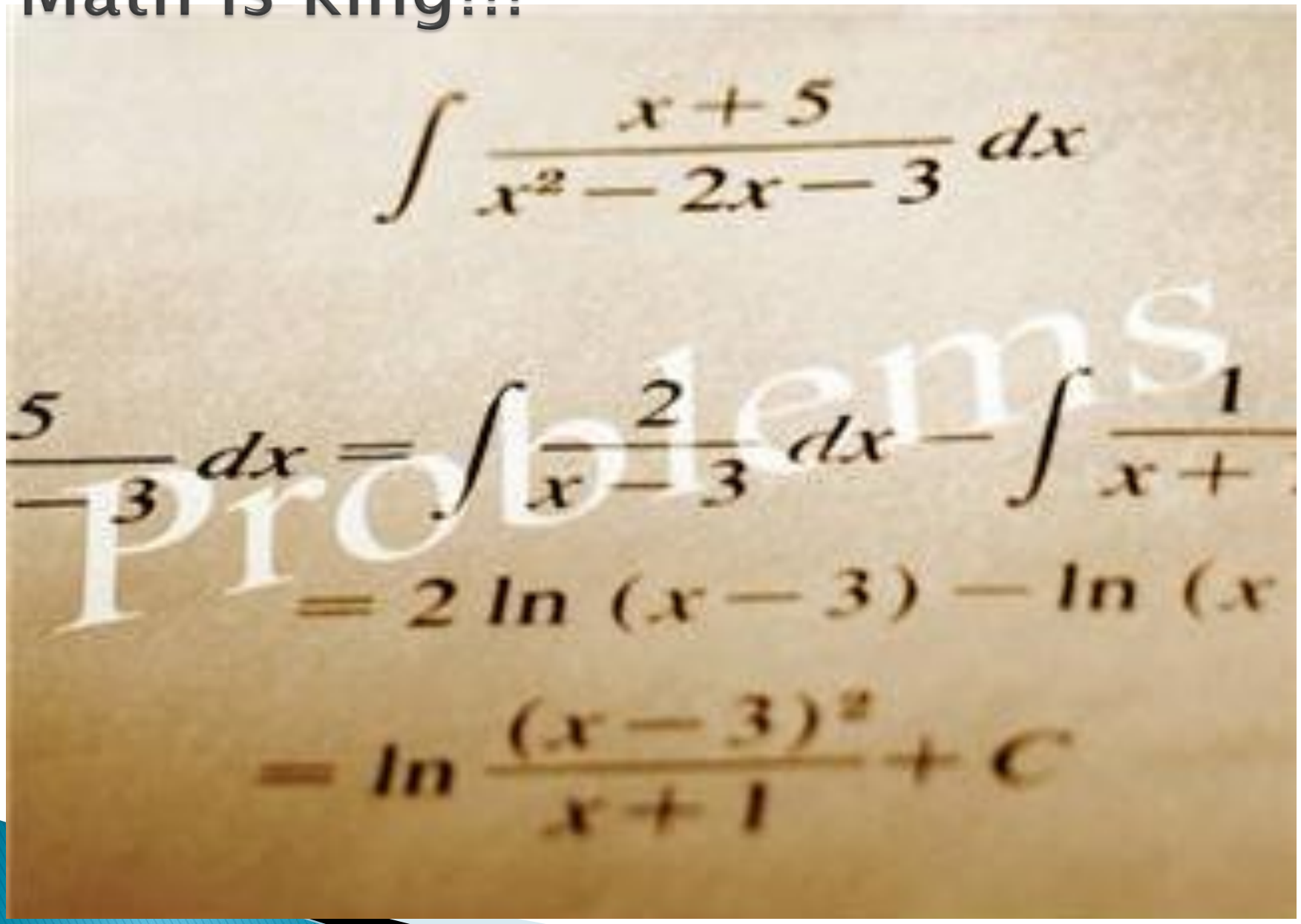
Introduce Experts

- Garmin:
  - Larry Linderman
  - Michael Reale
  - Ray Gearhard
  - Cheryl Werstler
  - Bill Leightenheimer
- Delorme:
  - Randy Park
- Magellan:
  - Walt Shields

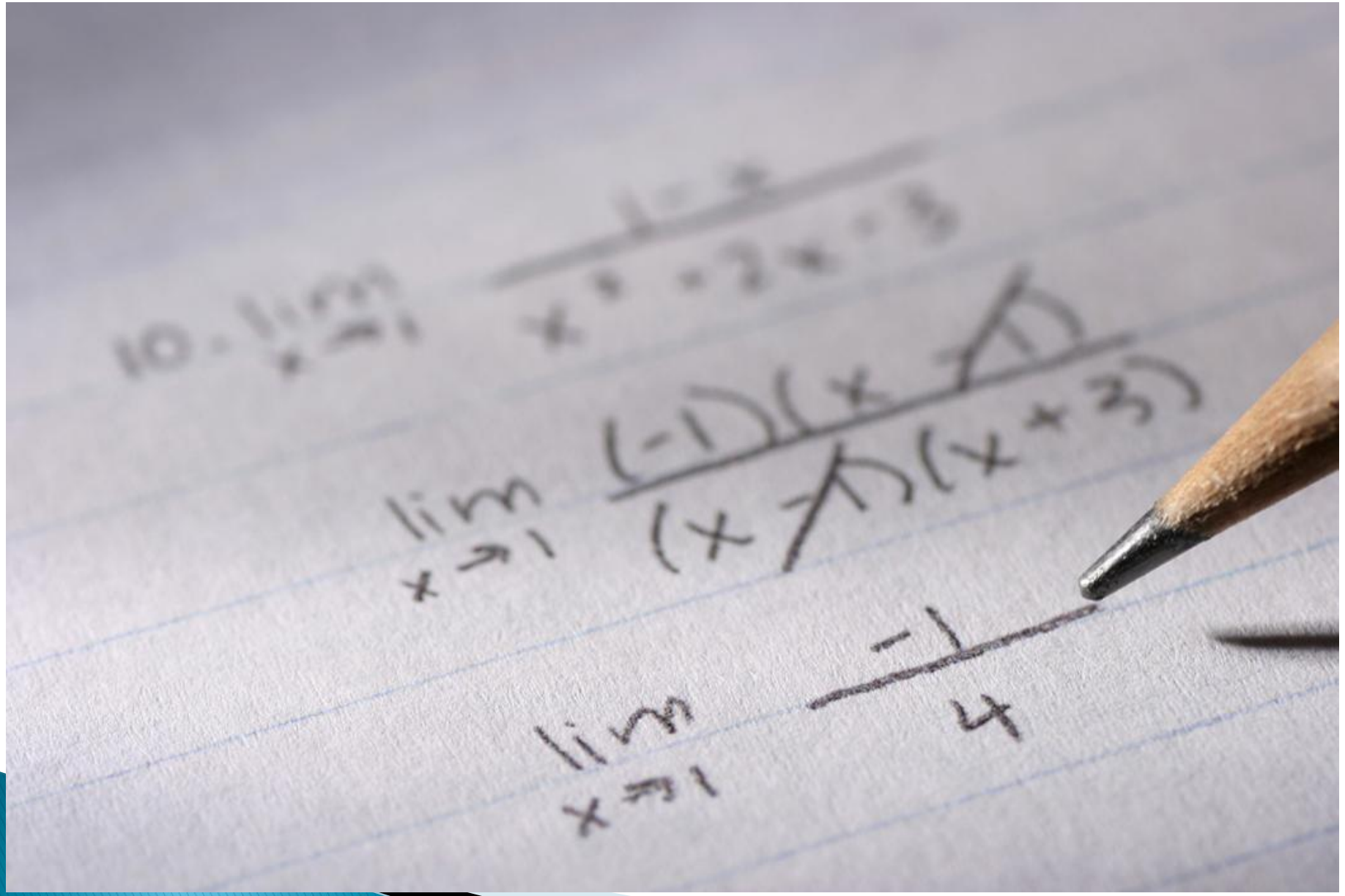
Will also help you during exercises

Did you bring your calculator?

Math is king!!!


$\int \frac{x+5}{x^2-2x-3}\,dx$
$\frac{5}{-3}\,dx = \int \frac{2}{x-3}\,dx - \int \frac{1}{x+$
$= 2\ln(x-3) - \ln(x$
$= \ln\frac{(x-3)^2}{x+1} + C$
Problems

Relax…… NO MATH



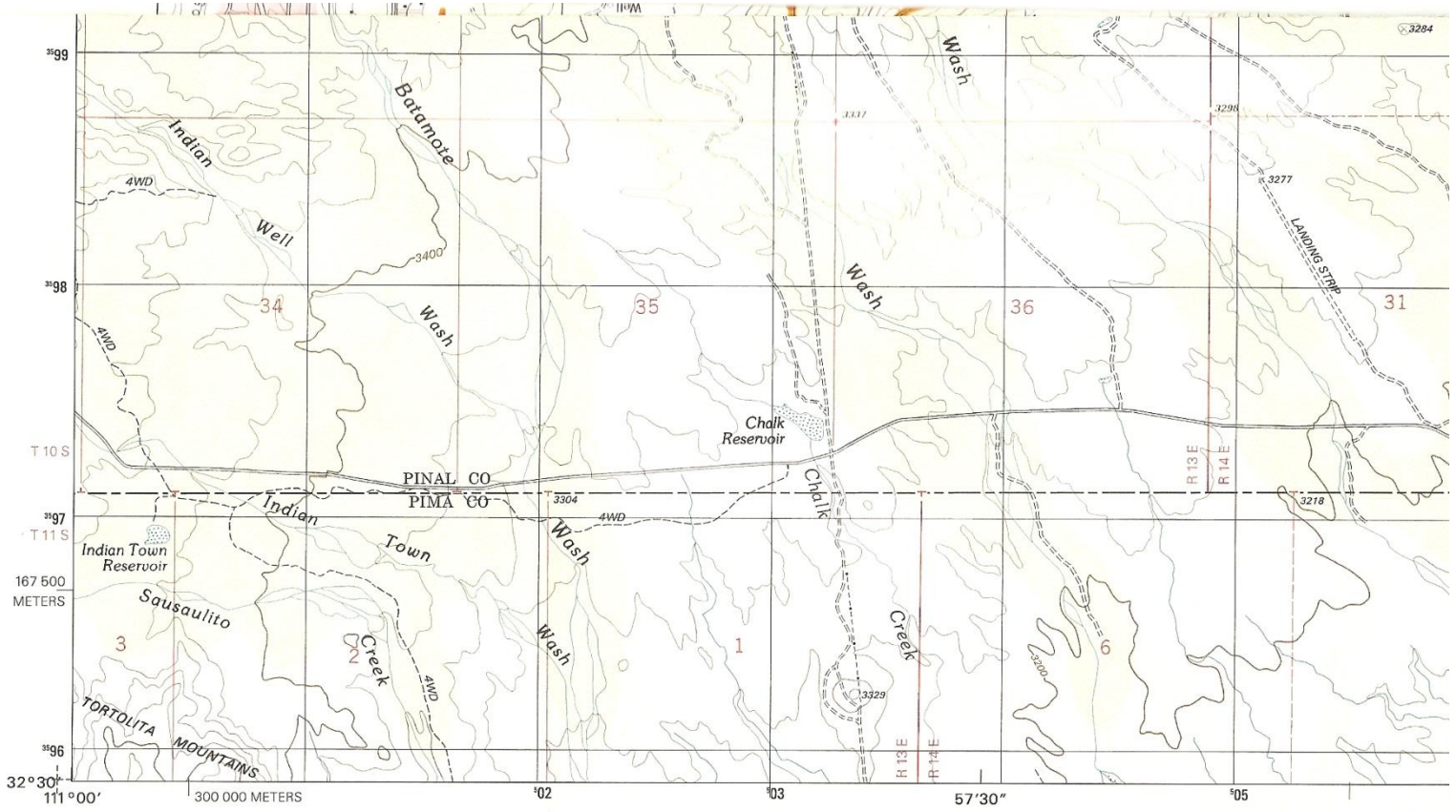
Topographic Maps 101

- USGS Quadrangles are best
  - Show both latitude and longitude, and Universal Transverse Mercator (UTM) coordinates
  - True north orientation but shows magnetic north
  - Shows natural features like streams, lakes, forest cover
  - Also shows basic manmade features, i.e., roads, towers, buildings (which may be grossly out of date)
  - Distance scales
  - Key to adjacent maps

Topographic Maps 101 (cont.)

- 1:24,000 quad maps are the most detailed, but less detailed scales are available (What does 1:24,000 mean?)
- Quad maps are 7.5 minute “rectangles” (why aren’t they square?)
- Contour lines (i.e., lines of equal elevation) are 40 feet apart
- Degrees: 0 to 360, minutes:0 to 60, seconds: 0 to 60
- How many quad maps would be needed to circle the earth? (360 x (60/7.5)) = 2880 one quad high
- Over 1900 quads are needed to cover Arizona
- Typical quad maps for Tucson area is about 7.3 miles wide and 8.6 miles high

Lower Left



Produced by the United States Geological Survey

Topography compiled 1958. Planimetry derived from imagery taken 1996 and other sources. Public Land Survey System and survey control current as of 1985. Boundaries current as of 2000

North American Datum of 1983 (NAD 83). Projection and 1 000-meter grid: Universal Transverse Mercator, zone 12
2 500-meter ticks: Arizona Coordinate System of 1983 (central zone)

North American Datum of 1927 (NAD 27) is shown by dashed corner ticks. The values of the shift between NAD 83 and NAD 27 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

Houses of worship, schools, and other labeled buildings verified 1985

MN
GN
0°02′
1 MIL
11½°
204 MILS

UTM GRID AND 2001 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:

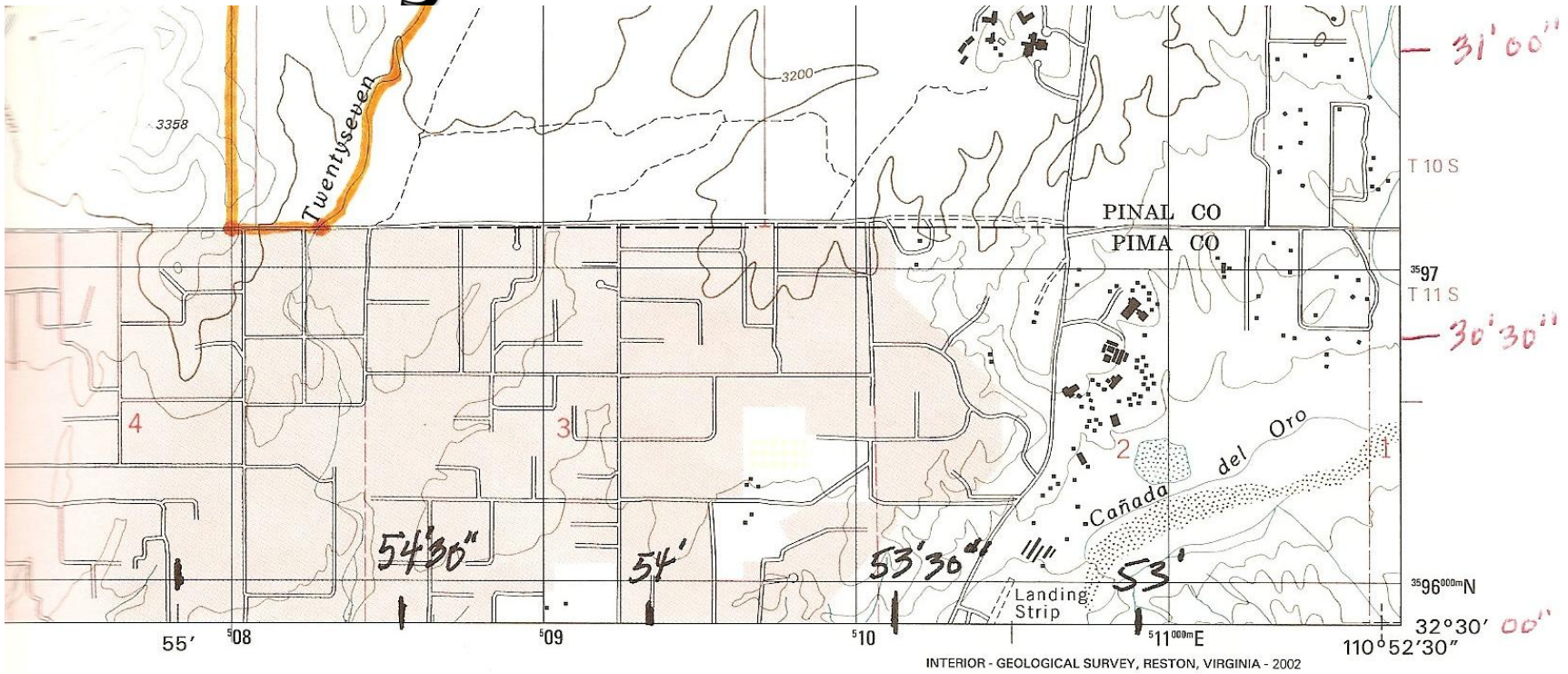
1 .5 0 KILOMETE
1000 0 METER
1 .5 0 MILES
1000 0 1000 2000 3000 4000 FEET

CONTOUR INTE
NATIONAL GEODETIC VER
TO CONVERT FROM FEET TO ME

20% TOTAL RECOVERED FIBER

THIS MAP COMPLIES WITH NATIONA
FOR SALE BY U.S. GEOLOGICAL SURVEY, P.C
A FOLDER DESCRIBING TOPOGRAPHIC MAPS A

Lower Right



INTERIOR - GEOLOGICAL SURVEY, RESTON, VIRGINIA - 2002

2 2000 1 10000

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway hard surface .....
Secondary highway hard surface .....
Light-duty road, hard or improved surface .....
Unimproved road .....
Interstate Route
U.S. Route
State Route

1	2	3
4		5
6	7	8

1 Chief Butte
2 Fortified Peak
3 North of Oracle
4 Tortolita Mountains
5 Oracle
6 Ruelas Canyon
7 Oro Valley
8 Mount Lemmon

ADJOINING 7.5' QUADRANGLE NAMES

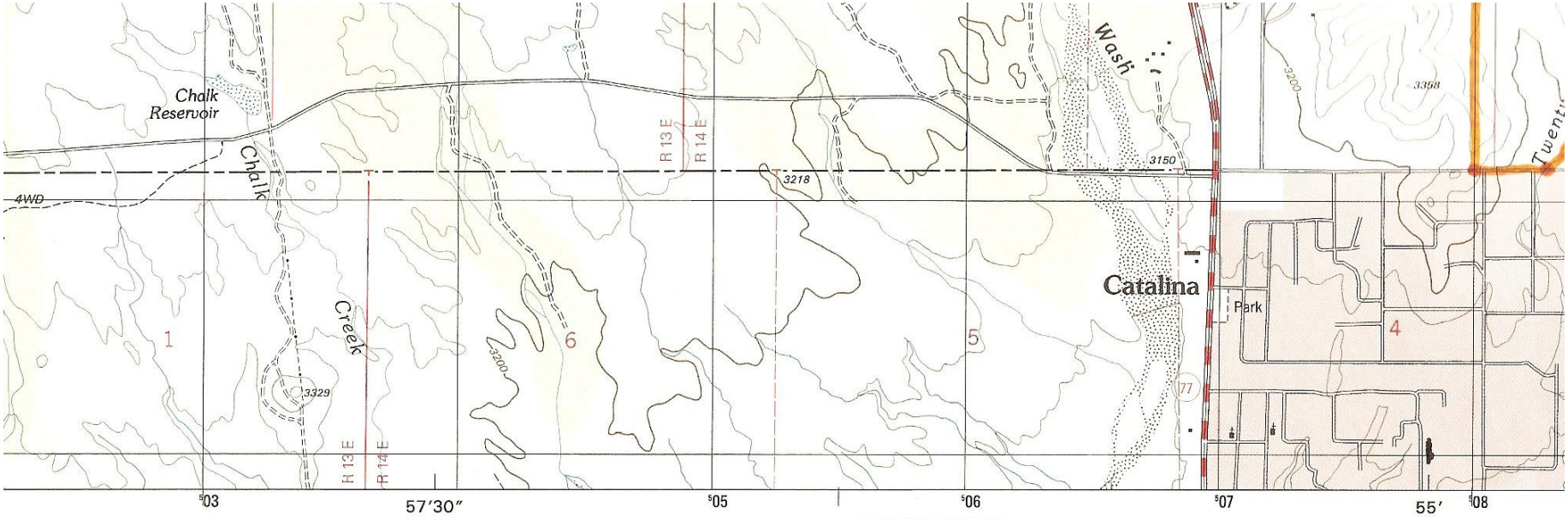
ORACLE JUNCTION, AZ

1996

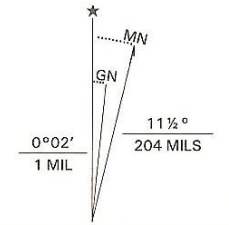
NIMA 3849 III SW-SERIES V898

ISBN 0-607-94805-1
9 780607 948059

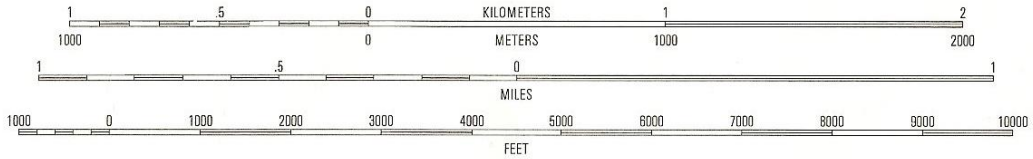
Lower Middle



SCALE 1:24 000



UTM GRID AND 2001 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET



CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
TO CONVERT FROM FEET TO METERS, MULTIPLY BY 0.3048

QU

1
4
6

ADJOINI

20%
TOTAL RECOVERED FIBER

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
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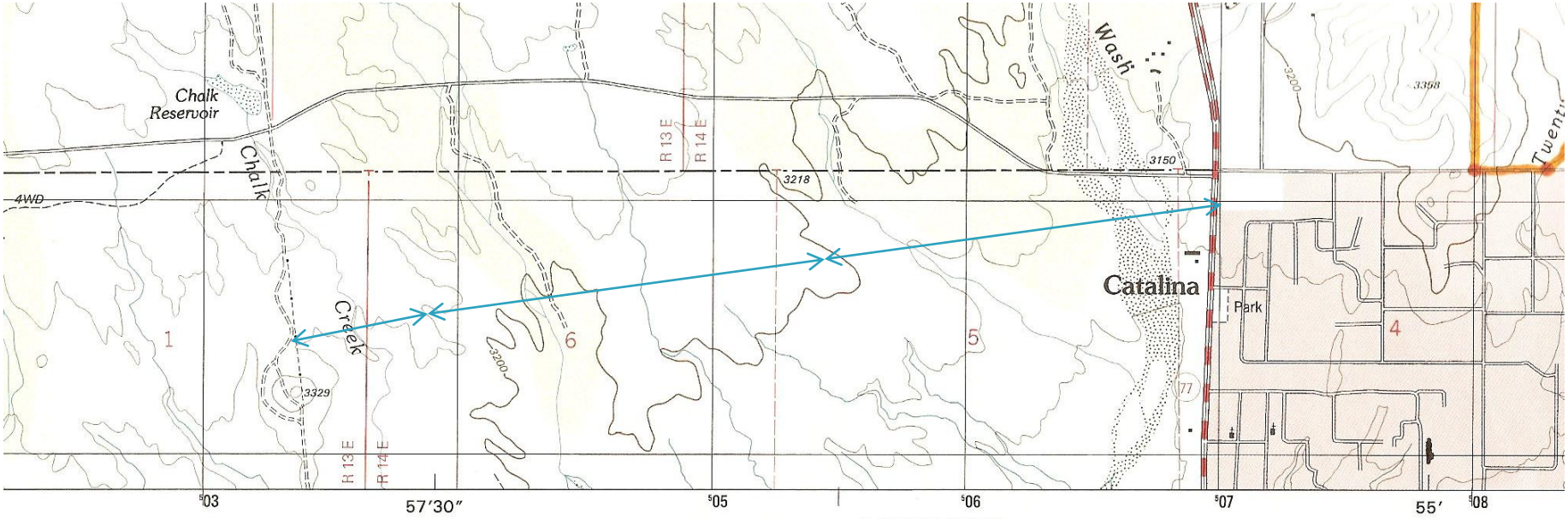
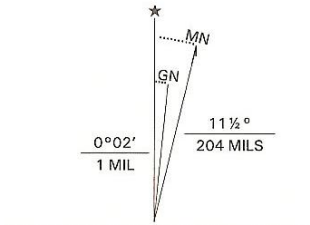
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Distance Scaling Example



SCALE 1:24 000



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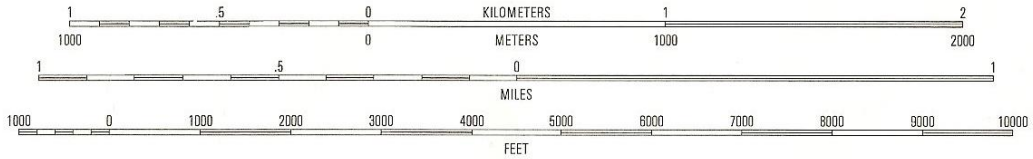

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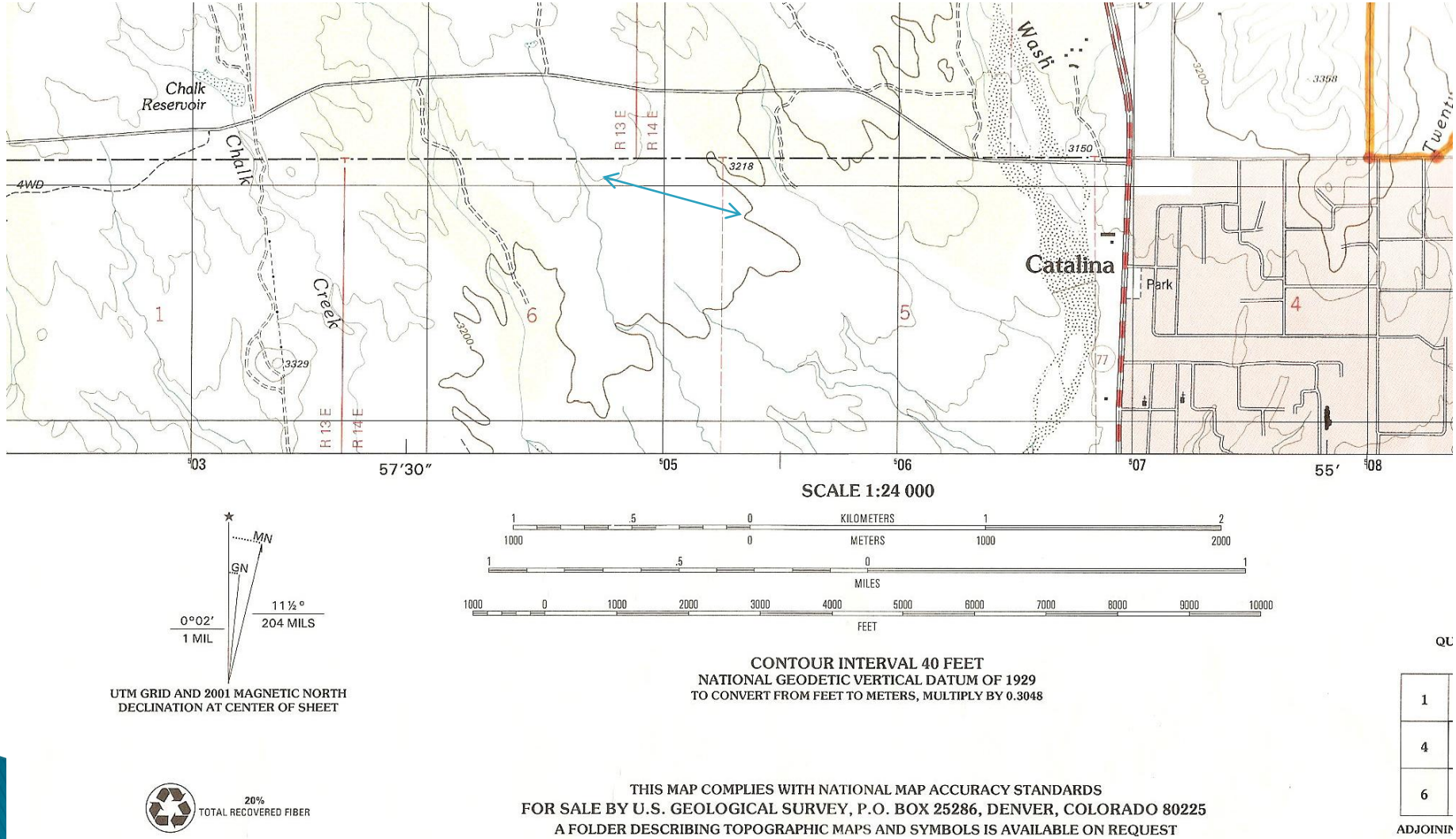
Exercises for Scaling Distance

- Between BM 3226 and Catalina Park in miles
- Between BM 3226 and ctr. Of Chalk Reservoir in miles
- Between Deep Well and Indian Town Reservoir in miles
- Between Deep Well and the intersection of Edwin Rd and Oracle Rd in Km
- Between Deep Well and the closest point on Rail X Rd in Km
- Between BM 3226 and the NW corner of Catalina in Km

Answers for Scaling Distance

- Between BM 3226 and Catalina Park in miles **(1.2)**
- Between BM 3226 and ctr. Of Chalk Reservoir in miles **(2.3)**
- Between Deep Well and Indian Town Reservoir in miles **(2.4)**
- Between Deep Well and the intersection of Edwin Rd and Oracle Rd in Km **(4.4)**
- Between Deep Well and the closest point on Rail X Rd in Km **(2.1)**
- Between BM 3226 and the NW corner of Catalina in Km **(1.6)**

Elevation Scaling Example



Exercises for Scaling Elevation (in feet)

- Between BM 3226 and Catalina Park
- Between BM 3226 and ctr. Of Chalk Reservoir
- Between Deep Well and Indian Town Reservoir
- Between Deep Well and the closest point on Edwin Road
- Between Deep Well and the closest point on Rail X Rd.
- Between BM 3226 and the NW corner of Catalina

Answers for Scaling Elevation (in feet)

- Between BM 3226 and Catalina Park **(66)**
- Between BM 3226 and ctr. Of Chalk Reservoir **(74)**
- Between Deep Well and Indian Town Reservoir **(110)**
- Between Deep Well and the intersection of Edwin Rd & Oracle Rd **(185)**
- Between Deep Well and the closest point on Rail X Rd. **(70)**
- Between BM 3226 and the red number “28” **(260)**

Which Coordinate System is best?

- Geographic: Latitude and Longitude
  - Measured in degrees, minutes, and seconds
  - There are 60 seconds in a minute and 60 minutes in a degree. There are 360 degrees around the earth
  - Map grid is marked every 2 minutes and 30 seconds on 1:24,000 USGS quad maps
- Grid based: UTM
  - Measured in meters
  - Map grid is marked every 1000 meters (1 kilometer) on 1:24,000 USGS quad maps

What do these sets of coordinates have in common?

- UTM
  - 12 S 0510464, 3598941
- Latitude, Longitude (degrees, minutes, seconds)
  - N 32º 31’ 39.6”, W 110º 53’ 19.2”
- Latitude, Longitude (degrees & fractions of degrees)
  - N 32.52767º, W 110.88865º
- Latitude Longitude (degrees & fractions of minutes)
  - N 32º 31.66’, 110º 53.32’

My House


N 32 0 31’ 45”
E 110 0 53’ 30”
THE Wash
Twentynine
Twentyseven
Wash
Well
4WD
Golf Course
PINAL CO
PIMA CO
T 10 S
T 11 S
Cañada del Oro
Landing Strip
32°30′ 00″
110°52′30″
INTERIOR - GEOLOGICAL SURVEY, RESTON, VIRGINIA - 2002
ROAD CLASSIFICATION
Primary highway hard surface
Secondary highway hard surface
Light-duty road, hard or improved surface
Unimproved road
Interstate Route
U.S. Route
State Route
QUADRANGLE LOCATION
1 Chief Butte
2 Fortified Peak
3 North of Oracle
4 Tortolita Mountains
5 Oracle
6 Ruelas Canyon
7 Oro Valley
8 Mount Lemmon
ADJOINING 7.5′ QUADRANGLE NAMES
ORACLE JUNCTION, AZ
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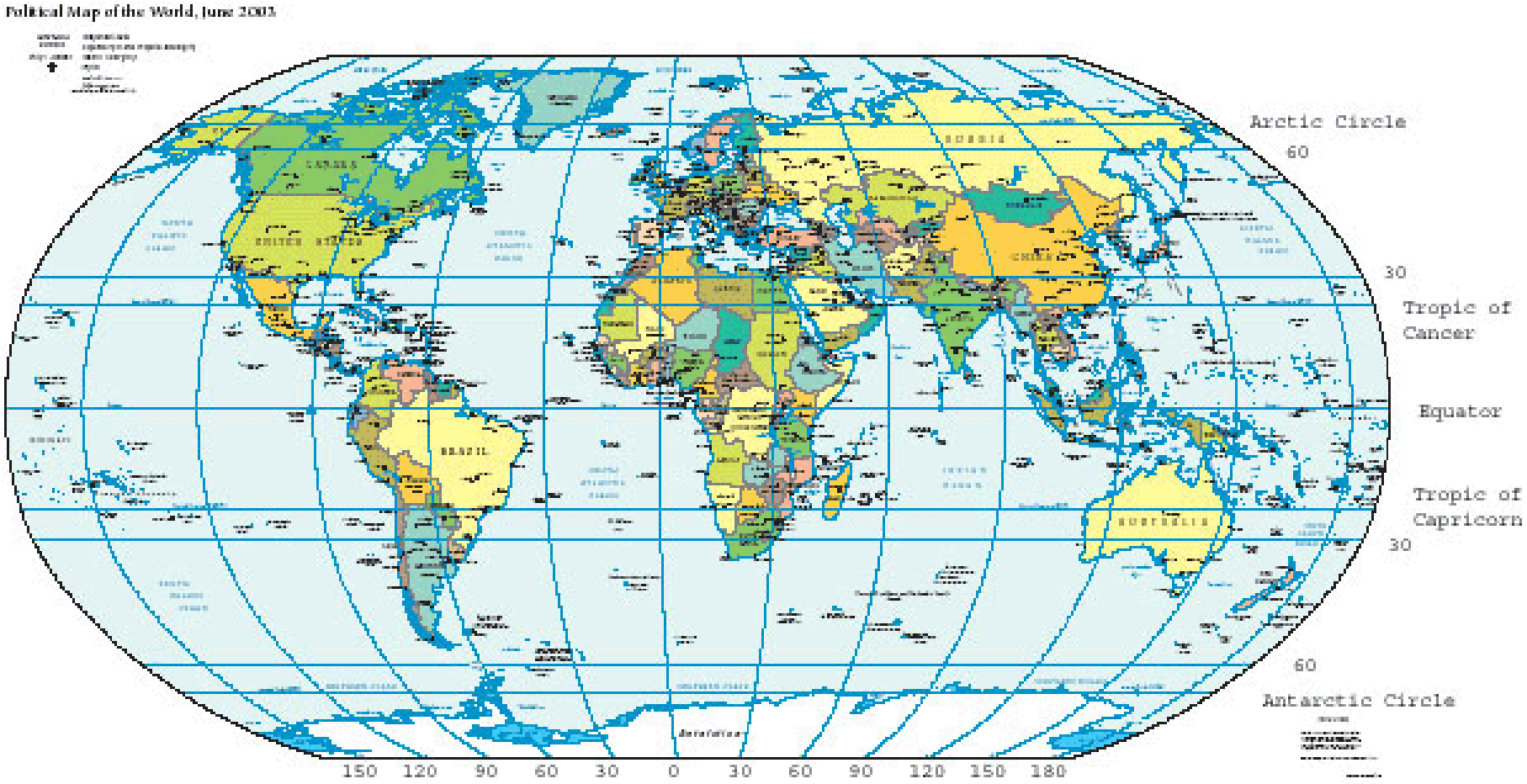
Geographic Coordinate System, i.e., Latitude & Longitude



Origin for Lat Lon Coordinates

- A line passing to the rear of the Royal Observatory, Greenwich, UK has been chosen as the international zero-longitude reference line, the Prime Meridian. Places to the east are in the eastern hemisphere, and places to the west are in the western hemisphere.
- The equator is the point of origin for latitude expressions.
- Units for Latitude & Longitude
  - Seconds range from 0” to 60”
  - Minutes range from 0’ to 60’
  - Degrees range from 0^{o} to 360^{0}

Using Lat Lon

- Magnetic vs. true north (11.5 deg in Tucson)
- In Tucson, longitude is roughly 111 degrees west of zero.
- In Tucson, latitude is roughly 32 degrees north of zero.

Exercises After Break

- Plot several locations using Lat Lon coordinates
- Provide handout map and give coordinates
- Follow up with on-screen location answer, guides provide “over-the-shoulder” help