

Cross Country Navigation

Wilderness Travel Course
2019



Presented by Neal Robbins

Navigation is...

- ■ ■ Is the art of staying found

Agenda

Topographic Maps

Elevation Contours

Terrain Recognition

Compass use and Declination

Map and Compass Use Together

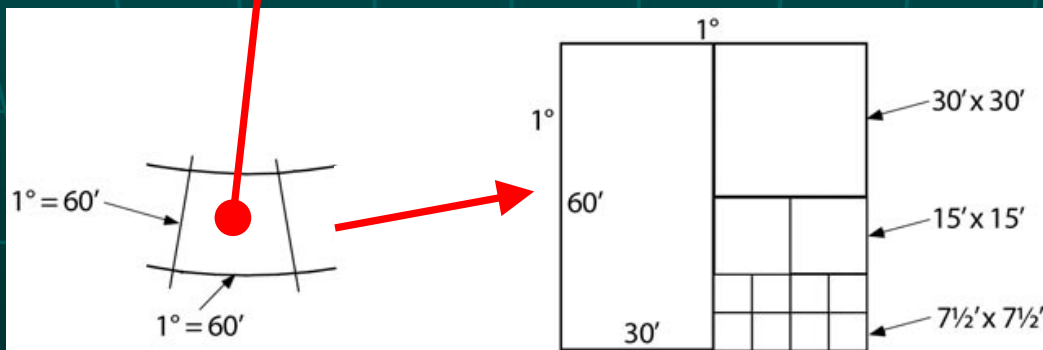
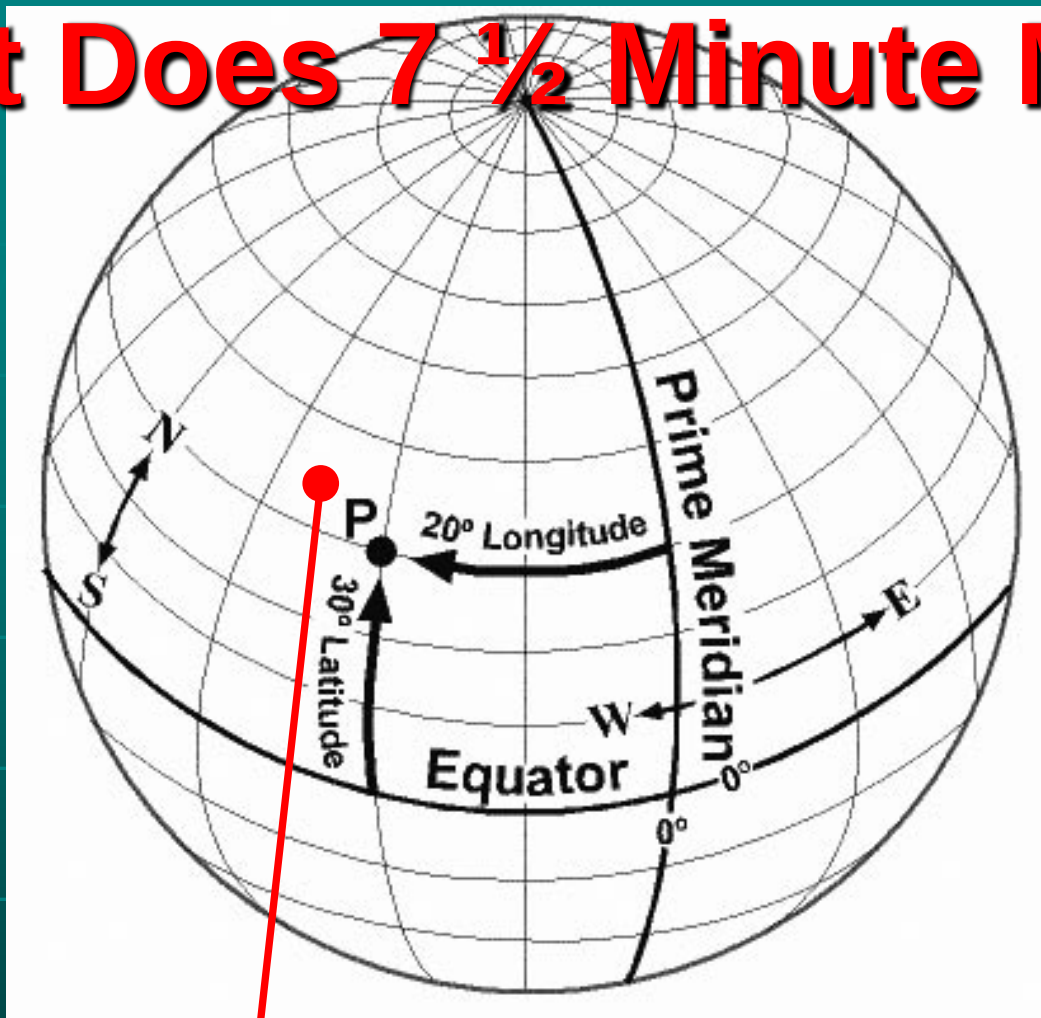
Trip Planning

Calculating the Time Required

Maps

- **Commercial / Auto Club**
- **Forest Service**
- **15 minute Commercial Maps**
 - Tom Harrison
 - Trails Illustrated
- **7 ½ minute Topographic Maps**
 - Also called Topos or Quads

What Does 7 1/2 Minute Mean

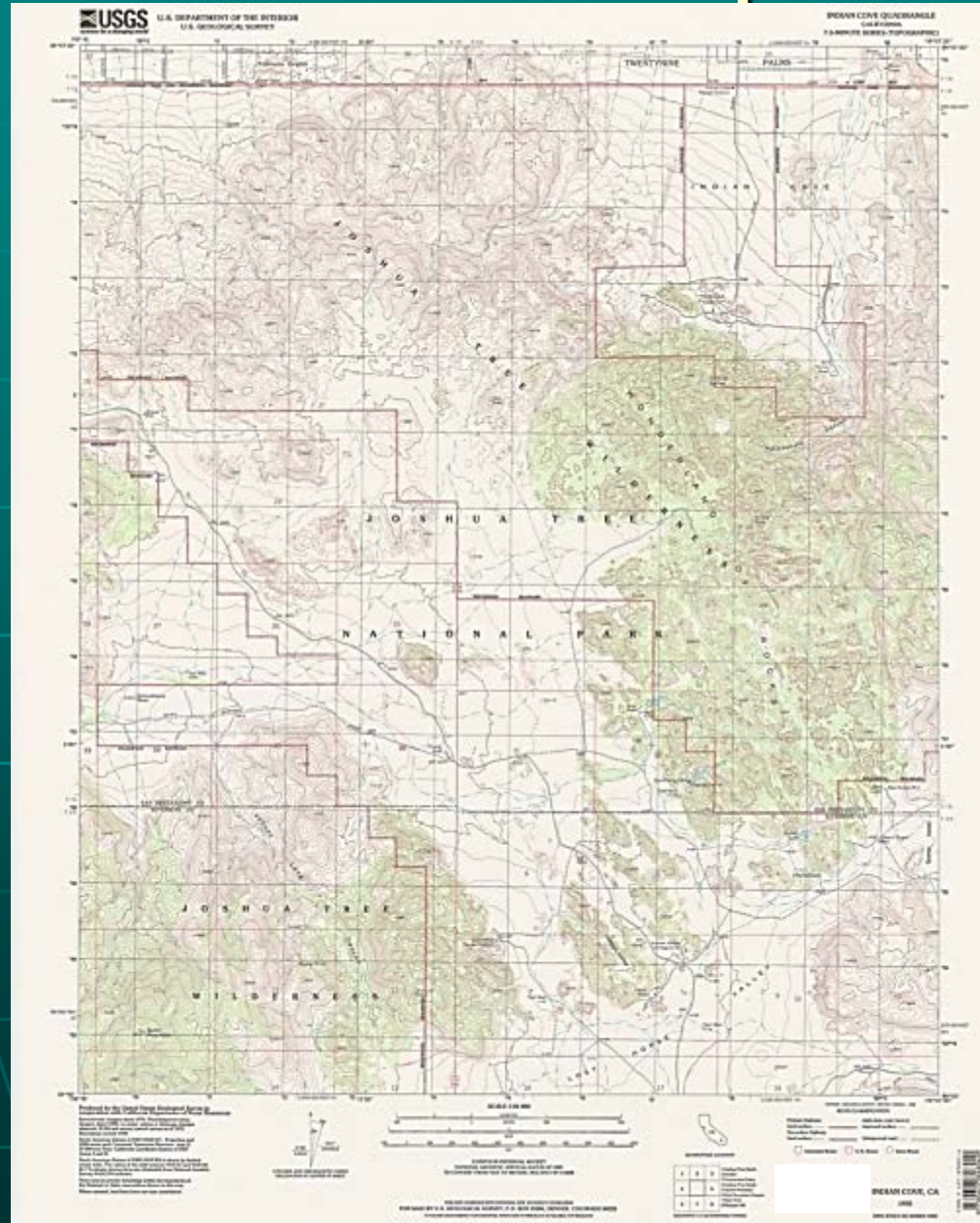


Topographic Maps

■ Topographic Maps

- 7 ½ Minute - covers area
 - 7 ½ minutes of latitude by
 - 7 ½ minutes of longitude
- Scale - 1:24000
- Named for a Prominent Map Feature
- Distance
 - 2.6 inches = 1 mile
 - 1 inch = 0.4 miles, 2000 feet, 24000 inches
 - 1/10th inch = 200 feet

“Indian Cove” Topo Map



Topo Map Definitions

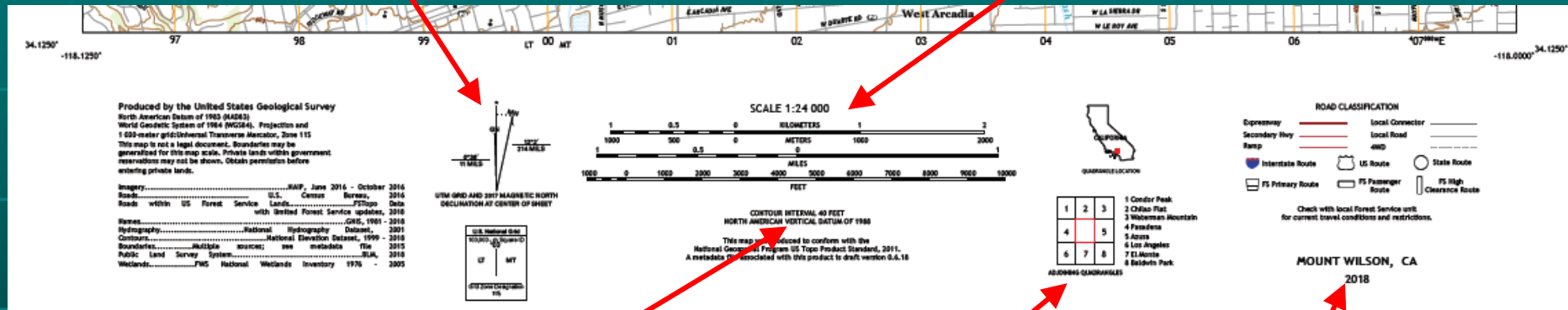
Declination

Linear Scale

Contour Interval

Adjacent Maps

Map Name
Revision Date



Topo Map Symbols

BATHYMETRIC FEATURES

Area exposed at mean low tide; sounding datum line***	
Channel***	
Sunken rock***	

BOUNDARIES

National	
State or territorial	
County or equivalent	
Civil township or equivalent	
Incorporated city or equivalent	
Federally administered park, reservation, or monument (external)	
Federally administered park, reservation, or monument (internal)	
State forest, park, reservation, or monument and large county park	
Forest Service administrative area*	
Forest Service ranger district*	
National Forest System land status, Forest Service lands*	
National Forest System land status, non-Forest Service lands*	
Small park (county or city)	

BUILDINGS AND RELATED FEATURES

Building	
School, house of worship	
Athletic field	
Built-up area	
Forest headquarters*	
Ranger district office*	
Guard station or work center*	
Racetrack or raceway	
Airport, paved landing strip, runway, taxiway, or apron	
Unpaved landing strip	
Well (other than water), windmill or wind generator	
Tanks	
Covered reservoir	
Gaging station	
Located or landmark object (feature as labeled)	
Boat ramp or boat access*	
Roadside park or rest area	
Picnic area	
Campground	
Winter recreation area*	
Cemetery	

COASTAL FEATURES

Foreshore flat	
Coral or rock reef	
Rock, bare or awash; dangerous to navigation	
Group of rocks, bare or awash	
Exposed wreck	
Depth curve, sounding	
Breakwater, pier, jetty, or wharf	
Seawall	
Oil or gas well, platform	

CONTOURS

Topographic	
Index	
Approximate or indefinite	
Intermediate	
Approximate or indefinite	
Supplementary	
Depression	
Cut	
Fill	
Continental divide	
Bathymetric	
Index***	
Intermediate***	
Index primary***	
Primary***	
Supplementary***	

CONTROL DATA AND MONUMENTS

Principal point**	
U.S. mineral or location monument	
River mileage marker	
Boundary monument	
Third-order or better elevation, with tablet	
Third-order or better elevation, recoverable mark, no tablet	
With number and elevation	
Horizontal control	
Third-order or better, permanent mark	
With third-order or better elevation	
With checked spot elevation	
Coincident with found section corner	
Unmonumented**	

CONTROL DATA AND MONUMENTS - continued

Vertical control	
Third-order or better elevation, with tablet	
Third-order or better elevation, recoverable mark, no tablet	
Bench mark coincident with found section corner	
Spot elevation	

GLACIERS AND PERMANENT SNOWFIELDS

Contours and limits	
Formlines	
Glacial advance	
Glacial retreat	

LAND SURVEYS

Public land survey system	
Range or Township line	
Location approximate	
Location doubtful	
Pretracted	
Pretracted (AK 1:63,360-scale)	
Range or Township labels	
Section line	
Location approximate	
Location doubtful	
Pretracted	
Pretracted (AK 1:63,360-scale)	
Section numbers	
Found section corner	
Found closing corner	
Witness corner	
Meander corner	
Weak corner*	
Other land surveys	
Range or Township line	
Section line	
Land grant, mining claim, donation land claim, or tract	
Land grant, homestead, mineral, or other special survey monument	
Fence or field lines	
MARINE SHORELINES	
Shoreline	
Apparent ledge of vegetation***	
Indefinite or unsurveyed	
MINES AND CAVES	
Quarry or open pit mine	
Gravel, sand, clay, or borrow pit	
Mine tunnel or cave entrance	
Mine shaft	
Prospect	
Tailings	
Mine dump	
Former disposal site or mine	

PROJECTION AND GRIDS

Needline	
Graticule tick	
Graticule intersection	
Datum shift tick	
State plane coordinate systems	
Primary zone tick	
Secondary zone tick	
Tertiary zone tick	
Quaternary zone tick	
Quinary zone tick	
Universal transverse mercator grid	
UTM grid (full grid)	
UTM grid ticks*	

RAILROADS AND RELATED FEATURES

Standard gauge railroad, single track	
Standard gauge railroad, multiple track	
Narrow gauge railroad, single track	
Narrow gauge railroad, multiple track	
Railroad siding	
Railroad in highway	
Railroad in road	
Railroad in light duty road*	
Railroad underpass, overpass	
Railroad bridge, drawbridge	
Railroad tunnel	
Railroad yard	
Railroad turntable; roundhouse	

RIVERS, LAKES, AND CANALS

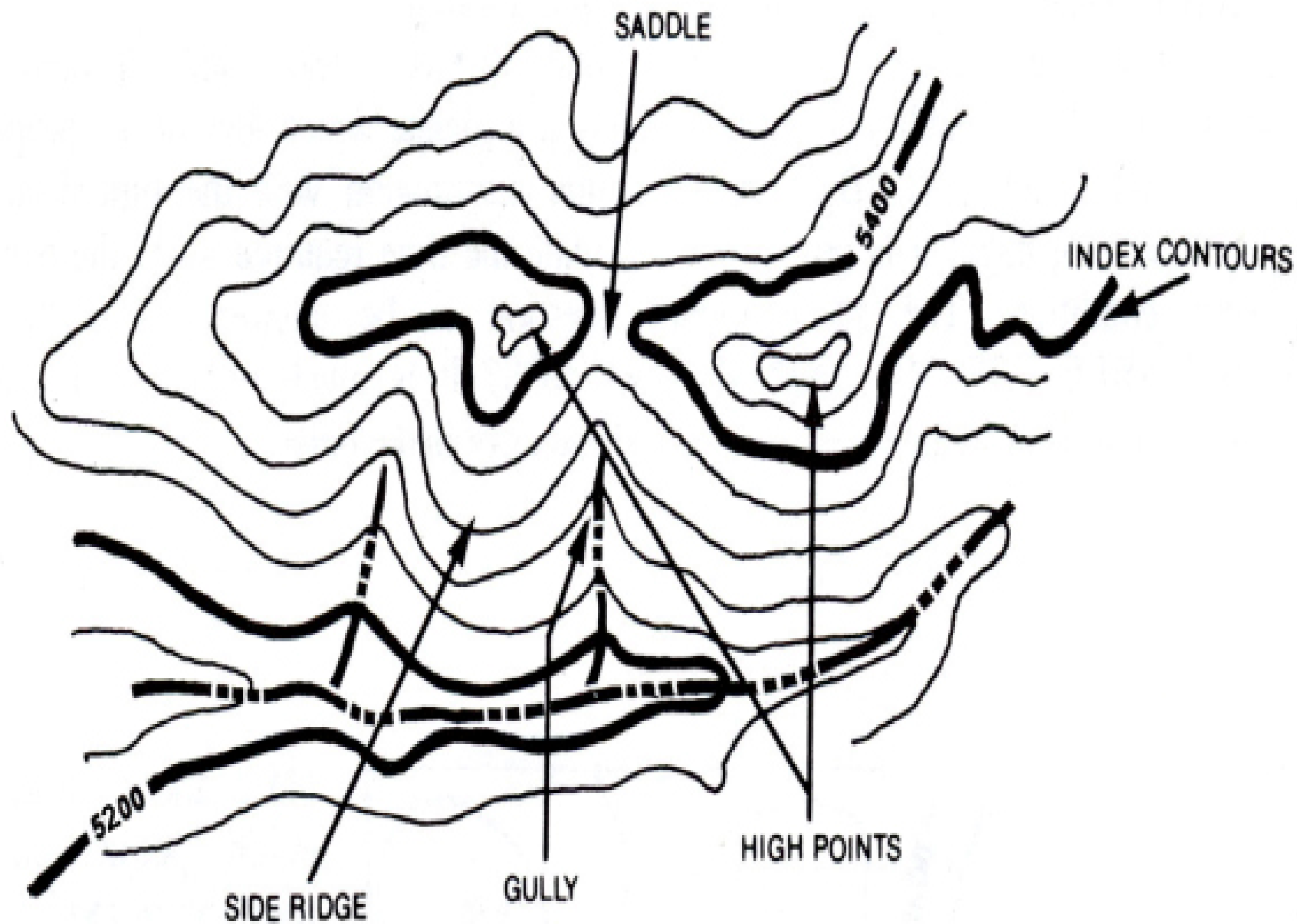
Perennial stream	
Perennial river	
Intermittent stream	
Intermittent river	
Disappearing stream	
Falls, small	
Falls, large	
Rapids, small	
Rapids, large	
Masonry dam	
Dam with lock	
Dam carrying road	

Contour Lines

- Lines of equal elevation used to portray topography
- Typical contour intervals:
 - 40 feet
 - 10 meters (66 feet)
 - 80 feet
- Index contour lines
 - Usually every 5th (some SM Mountains every 4th)
 - are darker and 200 feet apart

Contour Lines

- Contours resolve Topographic Features
 - Ridge and Gullies
 - Peaks or High Points
 - Saddles
 - Benches, Cliffs, and other features
- Law of “Vs”
 - Contours “V” up gullies and down ridges



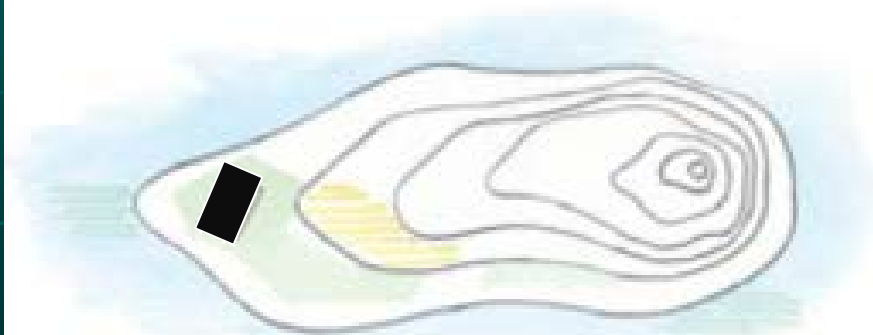
Representing Terrain



The Landscape

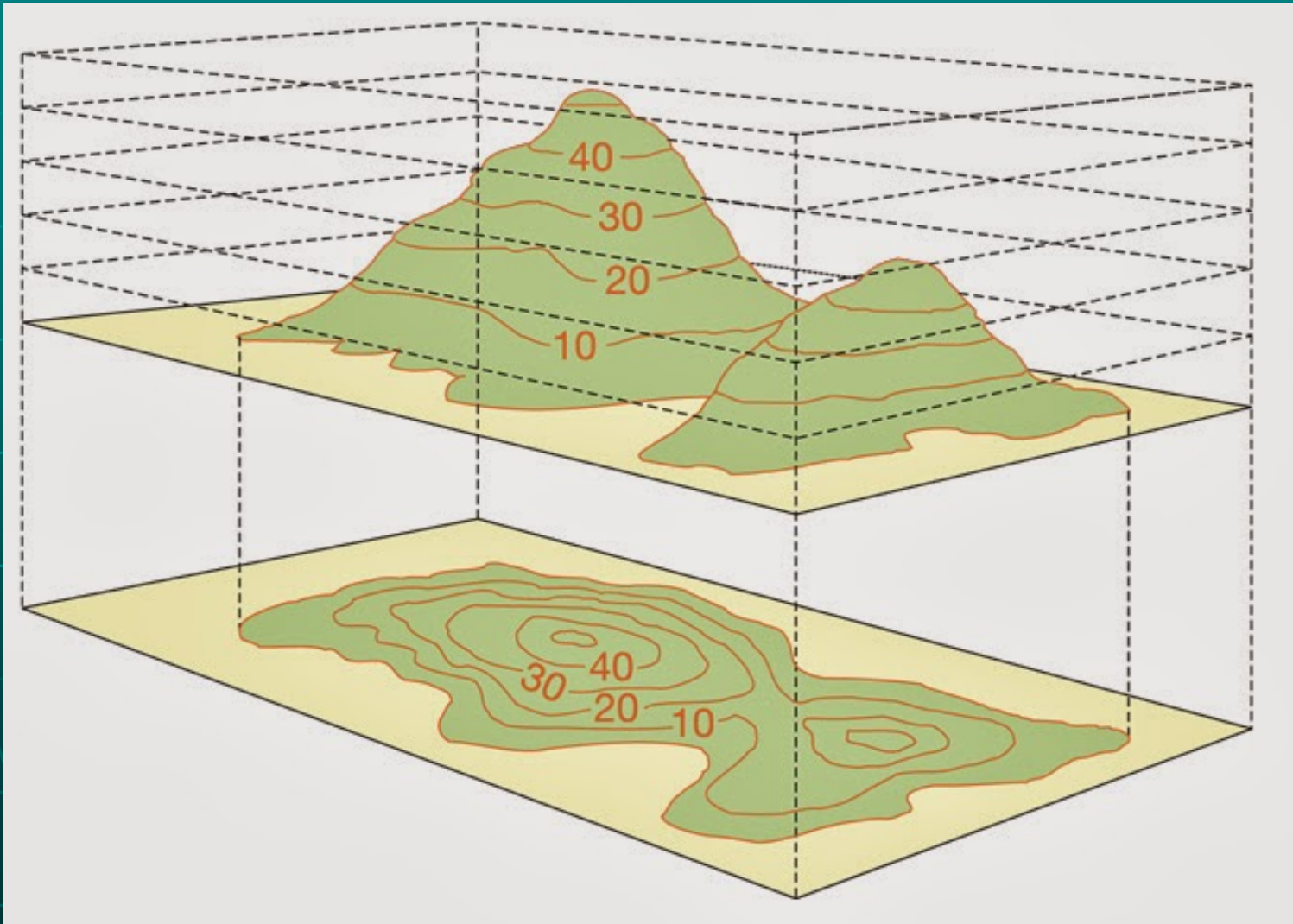


A Relief Model



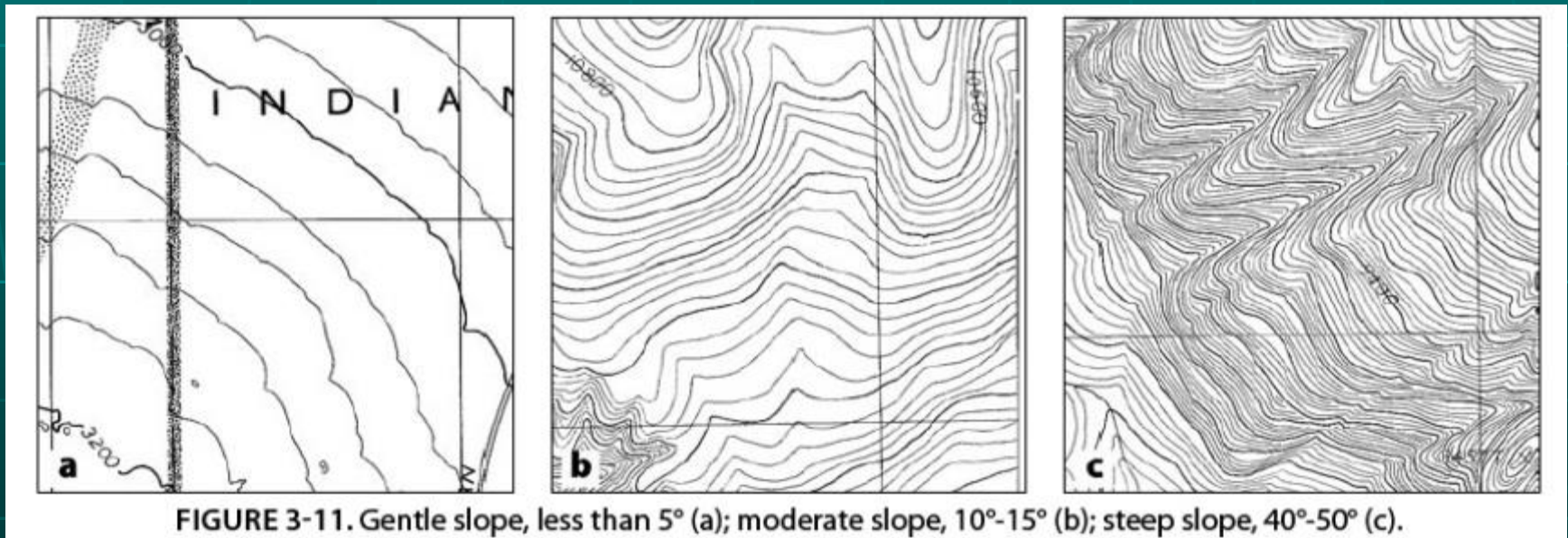
Contour Lines

Contour lines



Contour Lines - Slope

Important consideration for trip planning, especially cross country



Test Your Knowledge

1



2



3



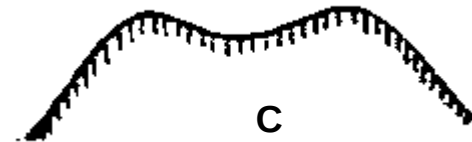
4



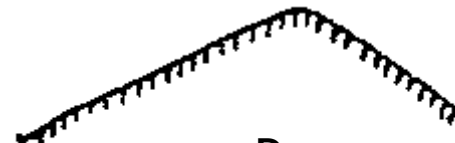
A



B

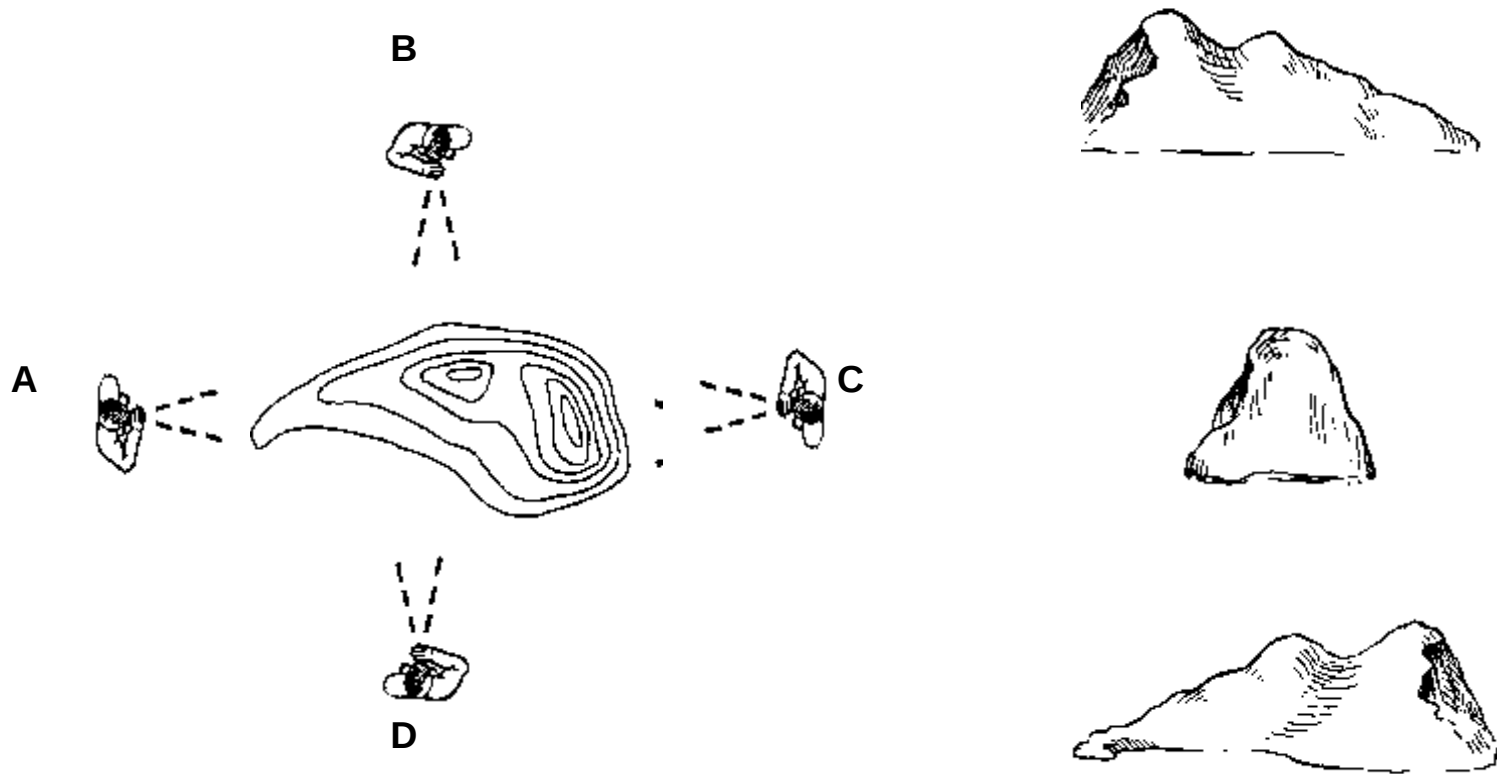


C

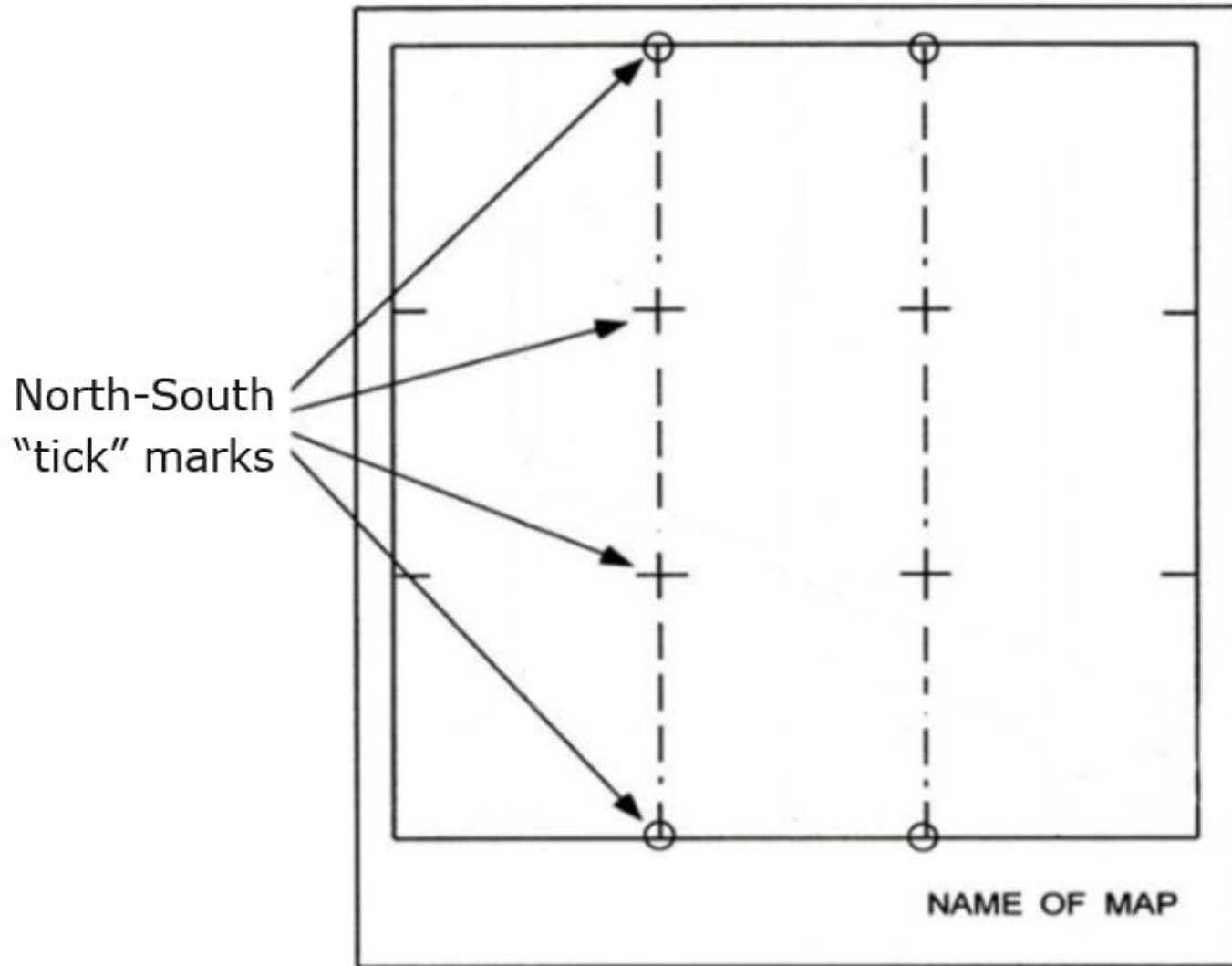


D

Where are you standing and what do you see?



Map Preparation



Map Preparation

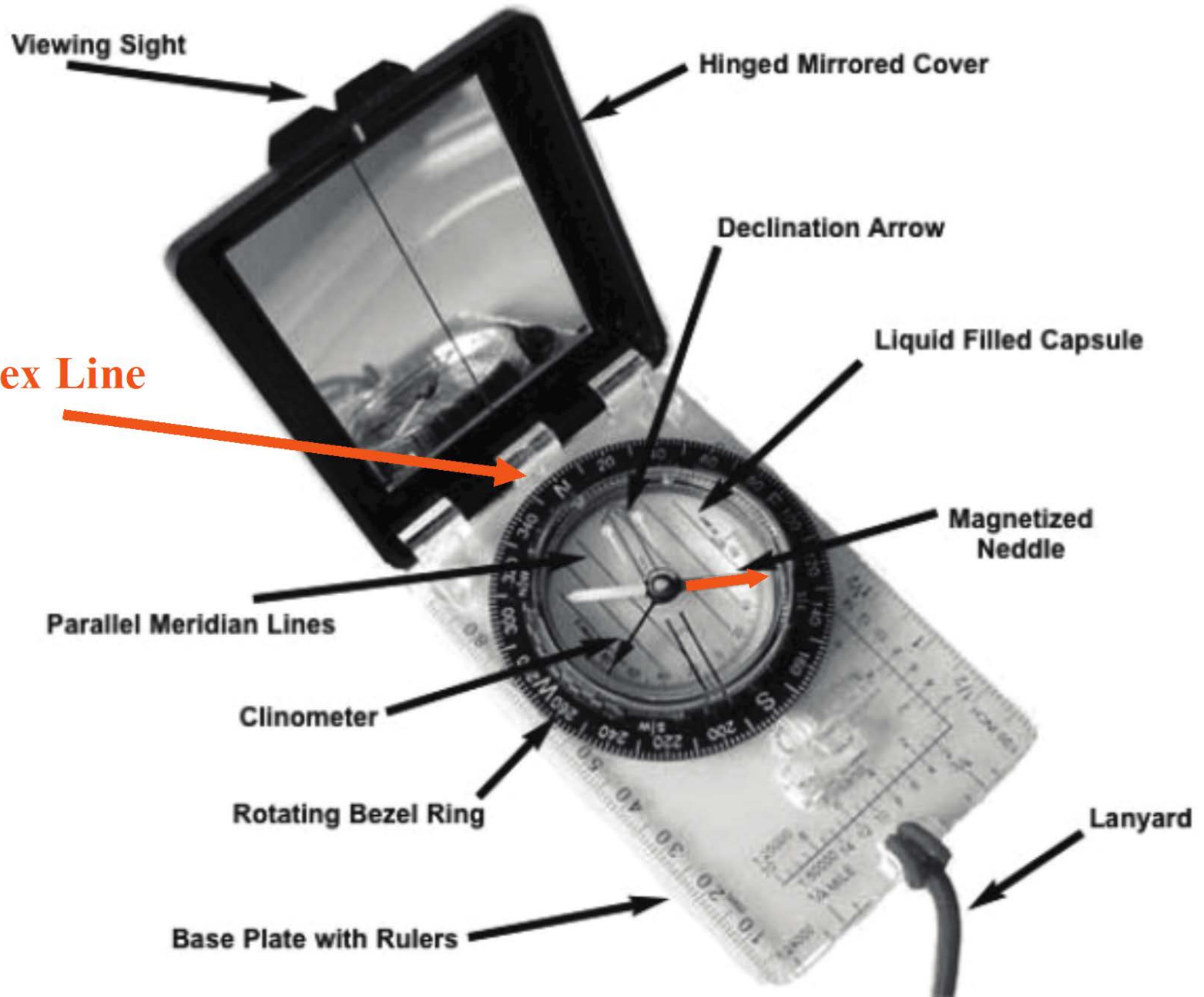
- Draw North-South Lines
 - In ~1 inch intervals
 - Used for plotting bearings
- Fold map for portion to be used
- Protect maps in a 1-gallon Ziploc or dedicated map case

Compass Basics

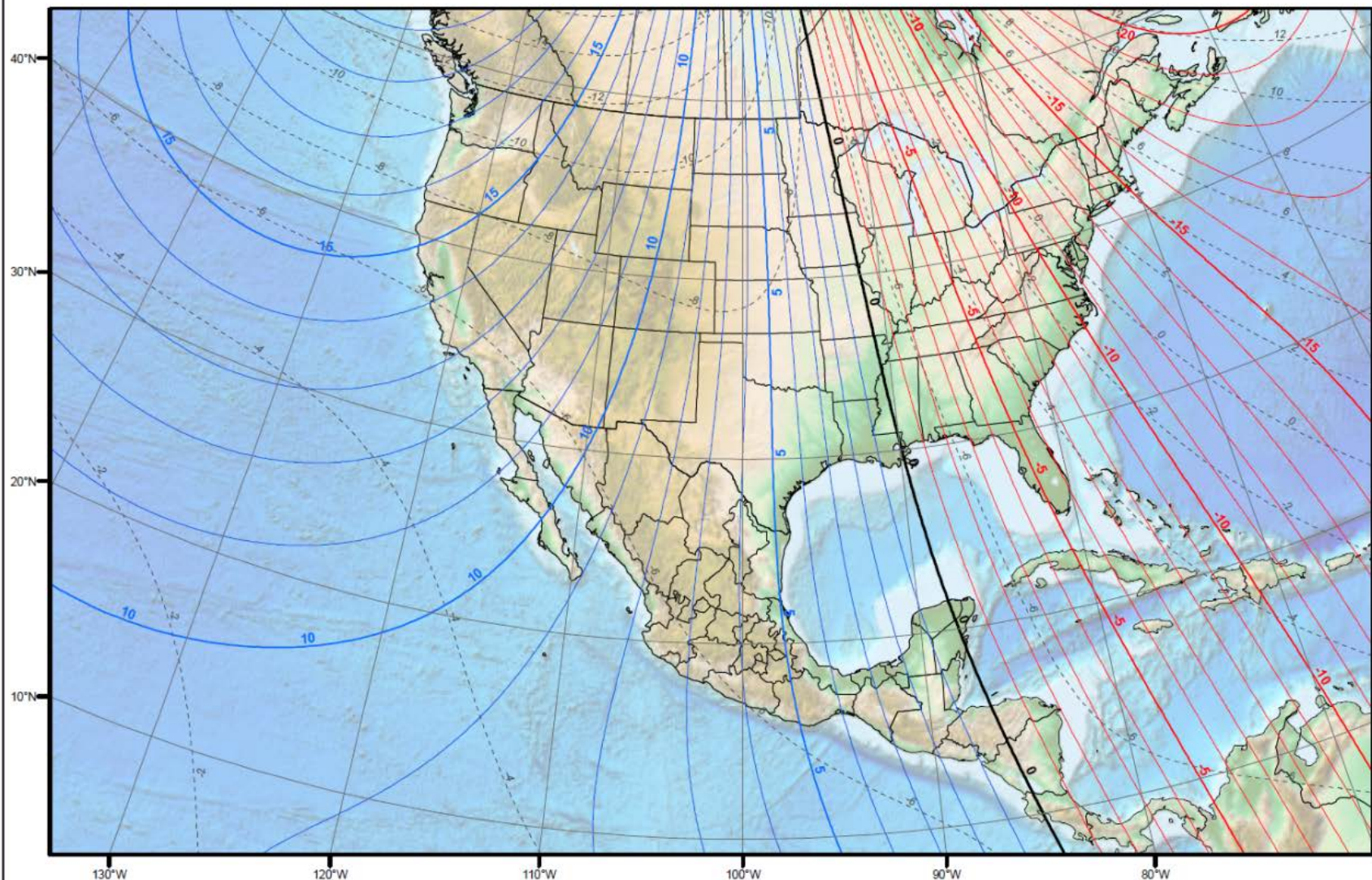
Compass

- The *only* all weather directional aid
- Maps are aligned with true north
- Compasses align with magnetic north
- A compass can measures bearings wrt true north if declination is set
 - A bearing is the direction from one point to another measured in degrees.

Index Line

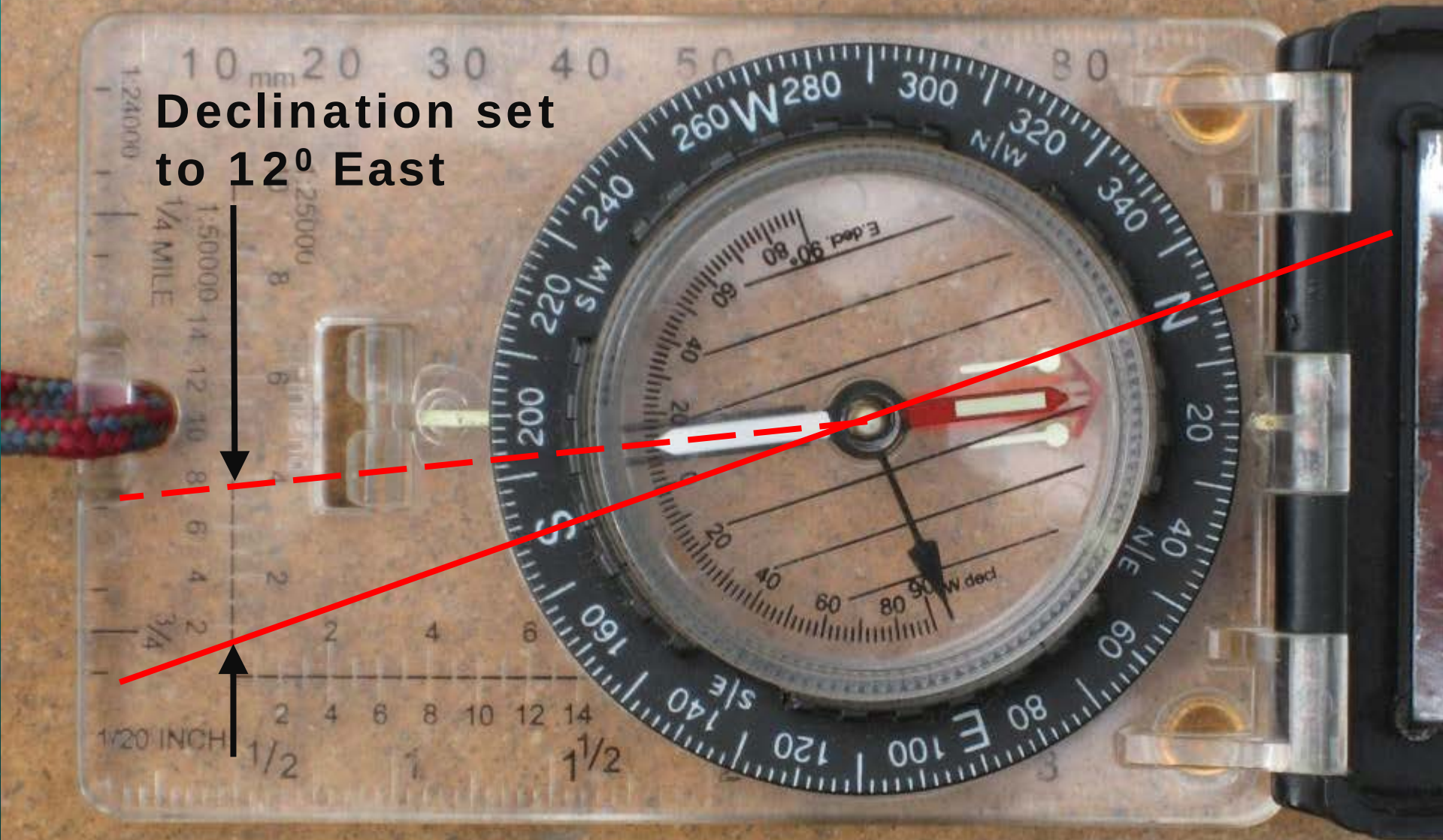


Magnetic Declination Map of North America for the year 2010



The term magnetic declination (also known as magnetic variation) refers to the angle between the magnetic north (MN - compass north) and true north (TN - true north) at any given latitude / longitude. The black contour line shows the imaginary line along which the declination is zero (MN and TN converges). The magnetic declination increases as one moves east or west from this line. The red line shows the **negative (west)** declination contours and the blue line shows the **positive (east)** declination contours. The degrees of declination required in order to orient the compass with the map is **added east** of this line and **subtracted west** of this line. (e.g., 10 degrees east would indicate that MN lies 10 degrees clockwise from the TN). Magnetic declination gradually changes with time and location. The dotted grey lines show the expected annual change in the magnetic declination in arc minutes. The above map is produced from the World Magnetic Model (WMM 2010) for the year 2010.

**Declination set
to 12° East**

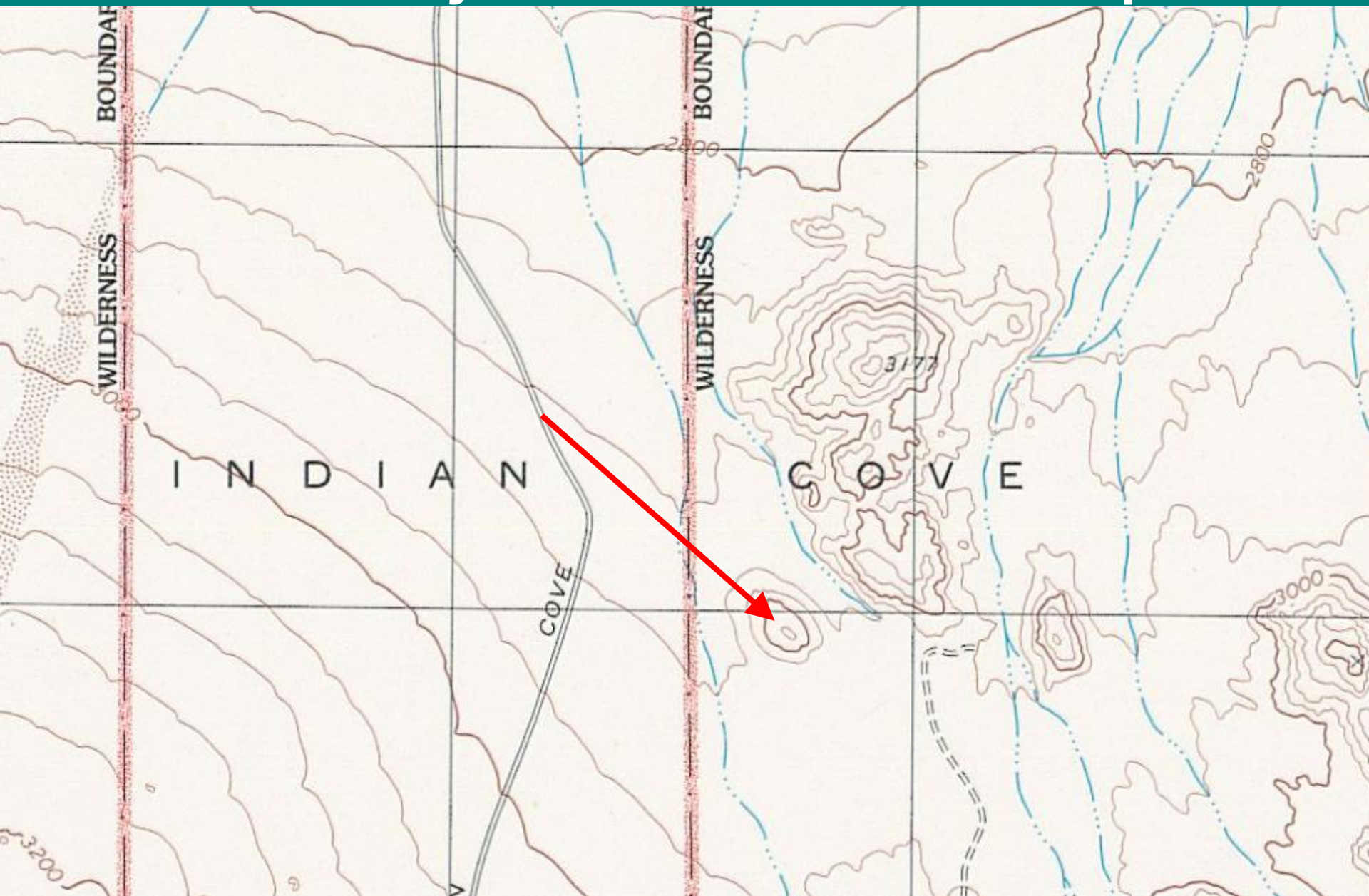


Orienting your Map to North

- Turn the compass dial to North
- Place the edge of your compass along a north-south line on your map
- With the map in front of you turn yourself so that the magnetic needle is boxed in the red arrow

Using a compass and map
together

Identify feature on the map

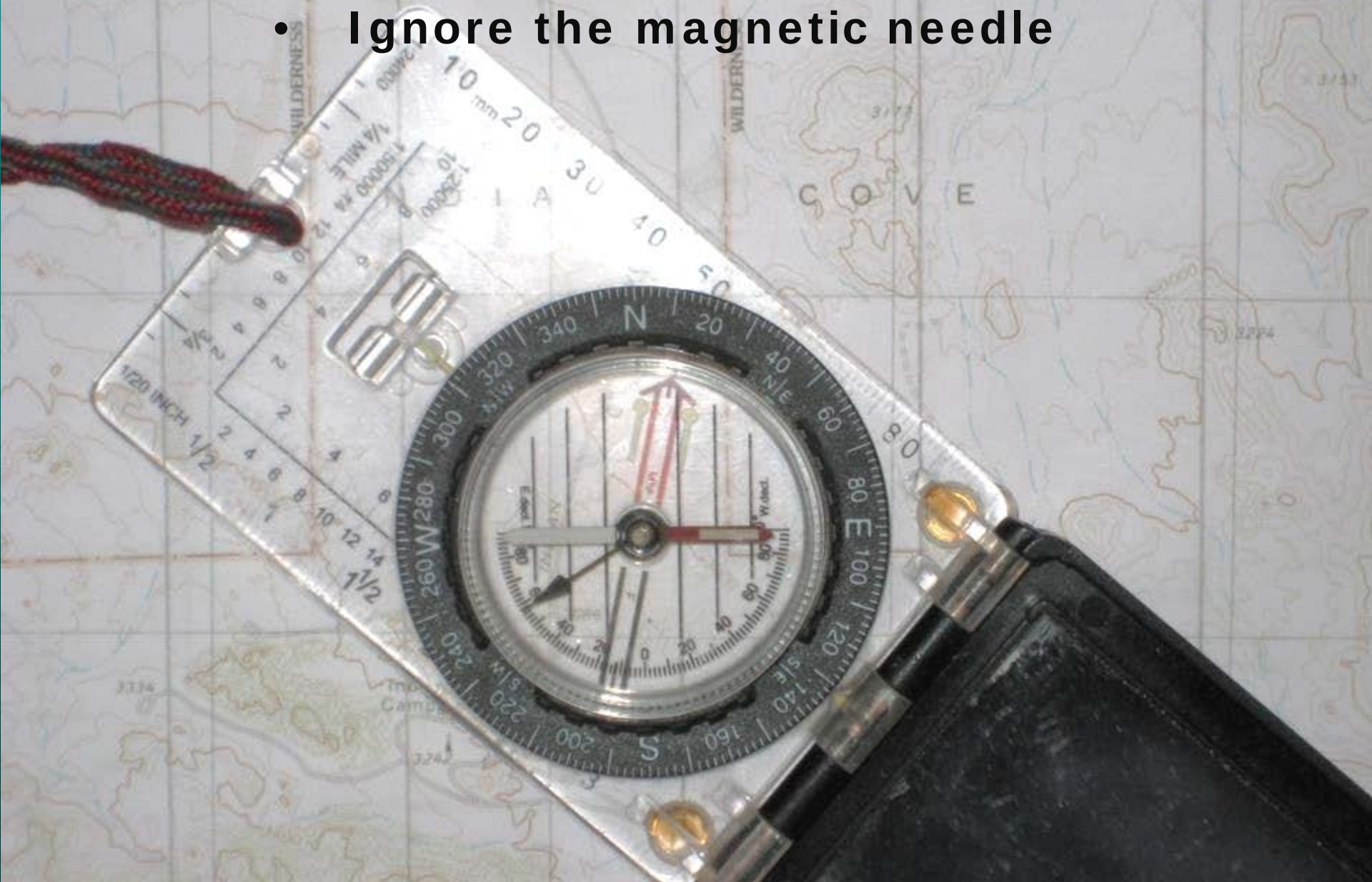


Take a bearing in the field

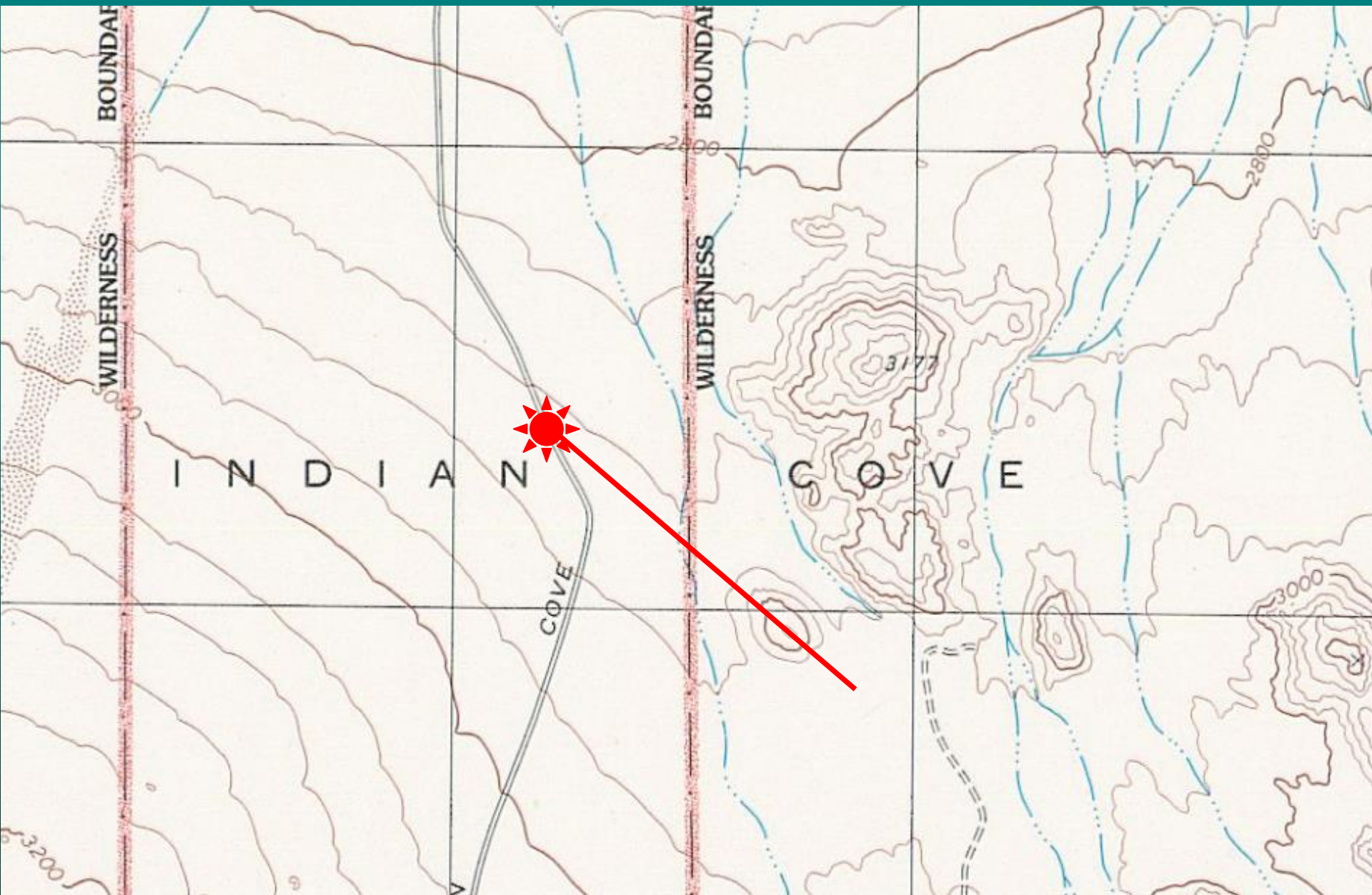


Plot the bearing on the map

- Use the compass as a protractor
- Ignore the magnetic needle



Where are you?

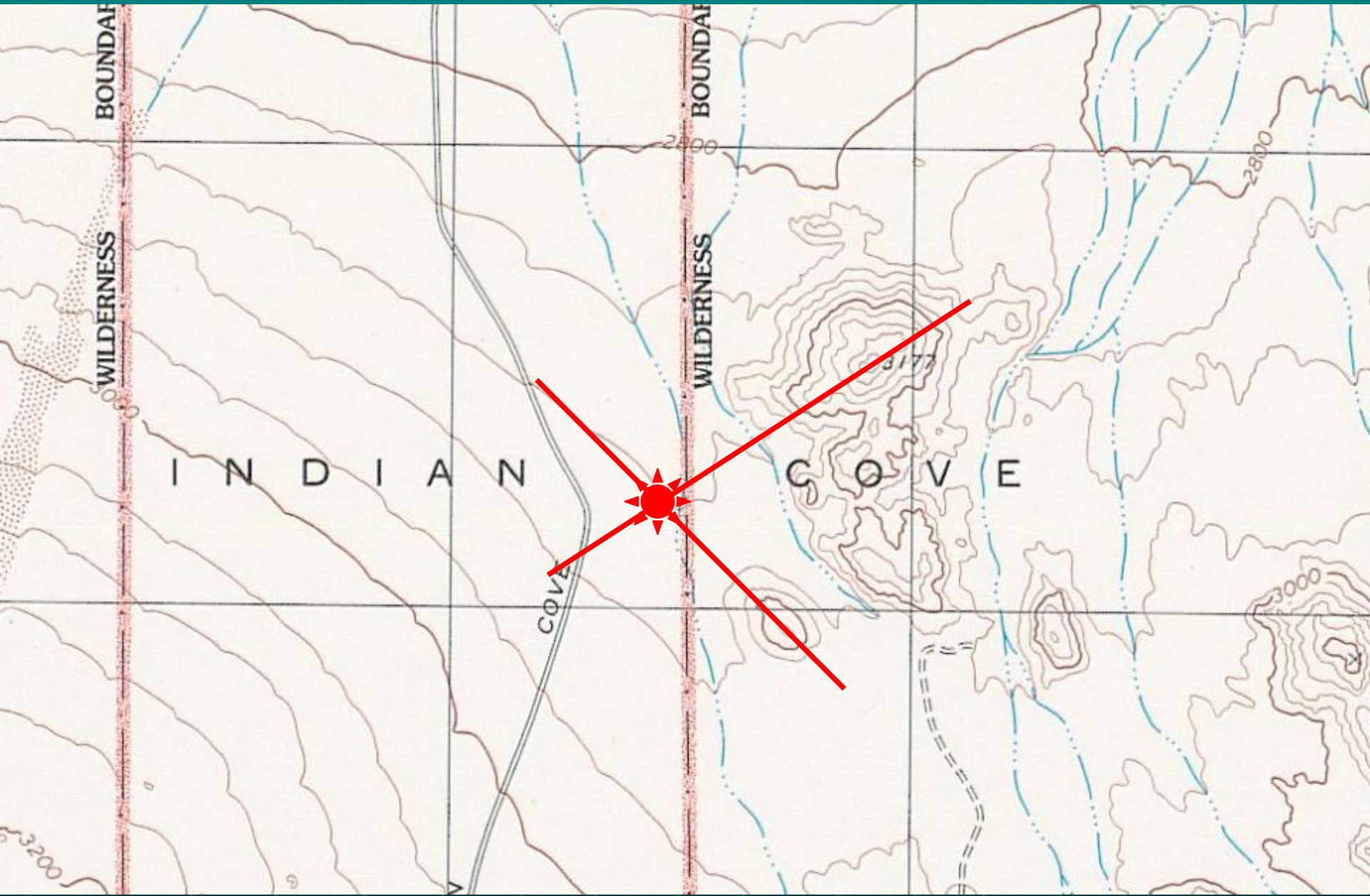


Draw line along edge of compass

Repeat process for a second feature







Time – Distance Estimates

Naismith's Rule:

- Trail hiking with light pack
 - $t = \frac{1}{3} \text{ distance} + \frac{1}{2} \text{ height (in K)}, \text{ or}$
- 3 MPH and 0.5 hour per 1000 feet of gain
 - $\frac{1}{10}^{\text{th}}$ mile = 2 min. 100' = 3 min.
- 9 miles with 3,000' gain = 4.5 hours
 - 9 miles / 3 mph = 3 hours
 - 3000 gain / 0.5 hours per 1000 = 1.5 hours

Time – Distance Estimates

Backpacker's Rule:

- On trail with a full backpack
 - $t = 2 \text{ distance} + 1 \text{ height (in K)}$, or
- 2 MPH and 1 hour per 1000 feet of gain
 - $1/10^{\text{th}}$ mile = 3 min. 100' = 6 min.
- 9 miles with 3,000' gain = 7.5 hours
 - 9 miles / 2 mph = 4.5 hours
 - 3000 gain / 1 hour per 1000 = 3.0 hours
- Same trip now takes 7.5 hours

Other Time Considerations

Need to add in time for:

- Number of Participants (1% each)
- Breaks and other stops
- Terrain Difficulty or “Squiggle Factor”
 - Stream, rock, or snow/ice crossings
 - Cross country travel
 - Vegetation, uneven surface, talus

What Have We Learned

- How to interpret a topo map
- How to take bearings with a compass
- How to use a map and compass together
- How to estimate time and distance

Final Advice

- PRACTICE your navigation skills
 - Attend a post-course Navigation Outing
- Keep map handy and anticipate features
- Work from close-in to farther away
- Keep track of progress
- Look behind you for return
- KNOW WHEN TO TURN BACK!
- Staying Found is YOUR Responsibility