

# **Geology and Geophysics 303**

## **Structural Geology**

### **Course Notes**

**Steve Martel**

**Department of Geology and Geophysics**

**University of Hawaii**

**<http://www.soest.hawaii.edu/martel/SteveM.html>**

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## INTRODUCTION AND COURSE PHILOSOPHY

## I Main Topics

- A What is science?
- B Course philosophy

## II What is science?

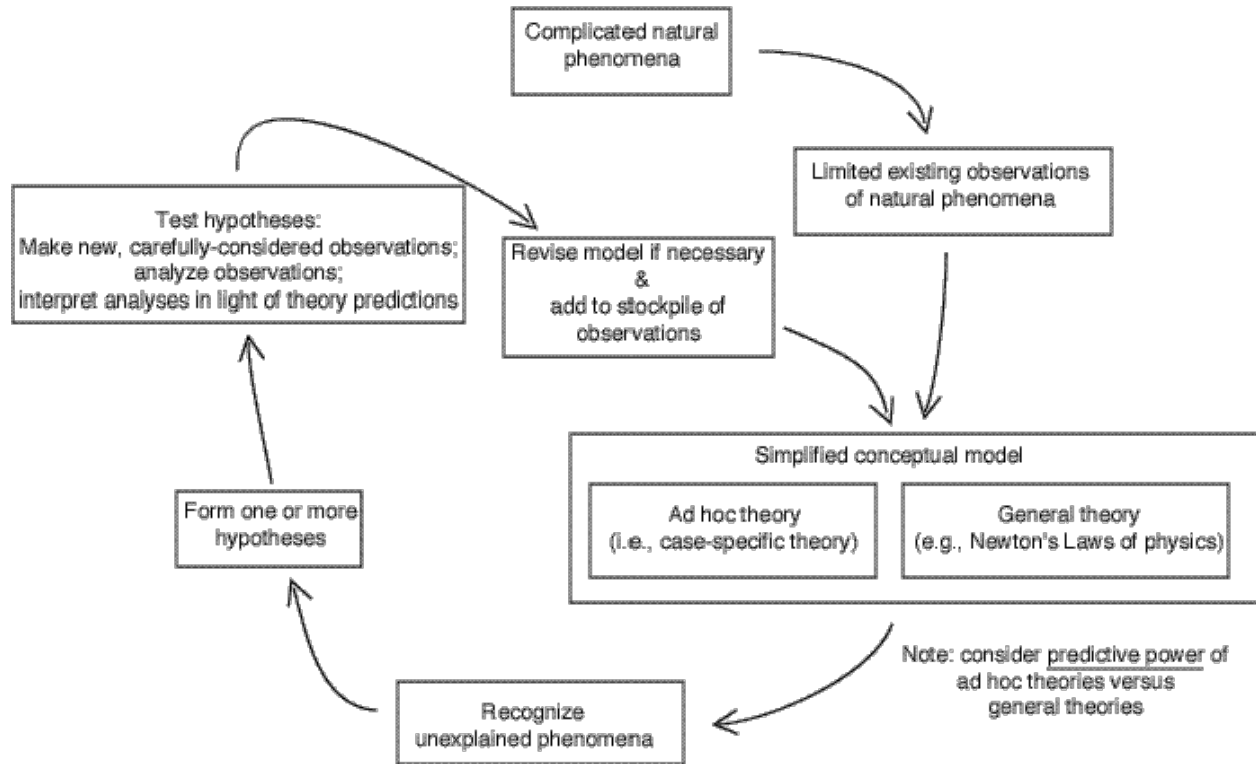
- A Possession of knowledge as distinguished from ignorance or misunderstanding;
- B Knowledge attained through study and practice
- C Knowledge covering general truths or the operation of general laws especially as obtained and tested through the scientific method
- D Scientific Method  
Principles and procedures for the *systematic* pursuit of knowledge involving the *recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses.*

## II Course philosophy

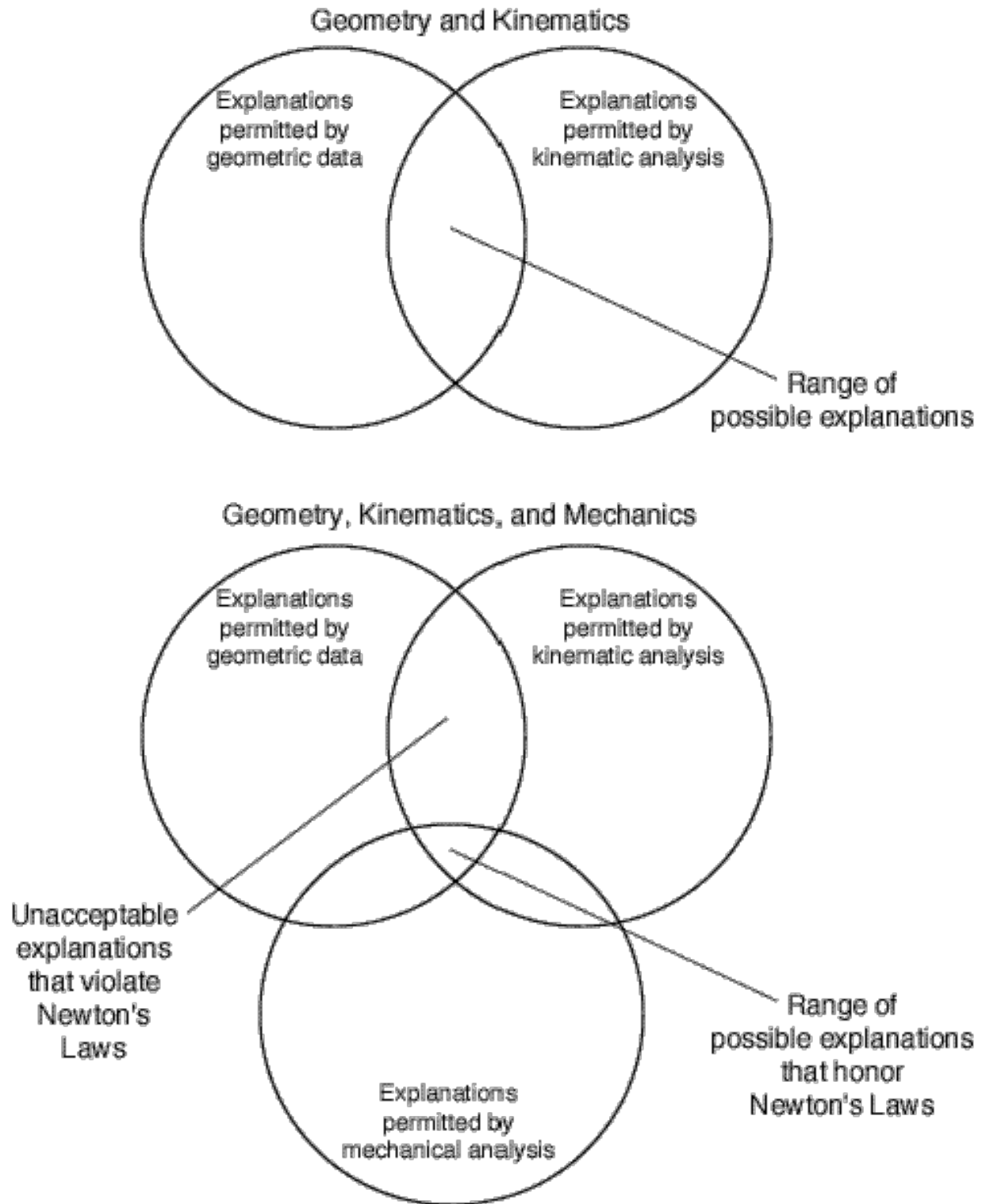
- A Geology can be treated as a scientific discipline
- B Course emphases
  - 1 Concepts (not vocabulary)
  - 2 Critical thinking (not “cookbooks”)
  - 3 Fundamentals (not fashion)
  - 4 Quantitative predictions (Where? When? How big?)
- C Topics of this course

Topic	Definition	Application to structural geology
Descriptive geometry	The representation of the spatial relationships of points lines and planes by means of projections	Used to describe the geometry of deformed or undeformed bodies Focus of first half of class
Kinematics	The study of the position of bodies through time without regard to the causative forces	Used to describe how a body changes shape and/or position through time
Mechanics	The study of forces and their effects (e.g., how bodies deform in response to forces)	Used to understand and <u>predict</u> how bodies deform

### Scientific Method



# Why Use Geometry, Kinematics, and Mechanics? Fig. 1.2





**Conversion Factors****Prefixes**

$\mu$ micro	$10^{-6}$
m milli	$10^{-3}$
k kilo	$10^3$
M mega	$10^6$
G giga	$10^9$

**Key constants**

g 9.8 m/sec/sec

**Quantities**

<b>Mass</b>	1 kg	1000 grams	2.205 lbs
	1 ton	2000 lbs	
	1 lb	0.4536 kg	

Note: tons and pounds are really weights (i.e., forces), not masses

<b>Length</b>	1 inch	2.54 cm	
	1 meter	39.37 inches	3.281 feet
	1 foot	0.3049 m	
	1 km	0.622 miles	
	1 mile	1609 meters	1.609 km

<b>Time</b>	1 year	$3.1557 \times 10^7$ sec
	1 hour	3600 sec

<b>Density</b>	1 g/cm <sup>3</sup>	1000 kg/m <sup>3</sup>
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<b>Force</b>	1 kg weight	9.807 N
F = ma	1 ton	2000 lbs
	1 lb	0.4536 kg
	1 kg	2.205 lbs
	1 N	$10^5$ dynes

<b>Pressure</b>	1 Mpa	$10^6$ Pa	1 MPa	145.03 psi
(P = F/area)	1 atm	$1.013 \times 10^5$ Pa	0.1013 MPa	14.7 psi
	1 bar	$10^5$ Pa	0.1 Mpa	14.503 psi
	10 bars	$10^6$ Pa	1Mpa	145.03 psi
	1 psi	689.5 Pa	$689.5 \times 10^{-3}$ MPa	1 psi
	10 m water	$\approx 10^5$ Pa	$\approx 0.1$ Mpa	$\approx 14.7$ psi

<b>Energy</b>	1 calorie	4.184 joule
	1 joule	$10^7$ ergs

<b>Power</b>	1 watt	1 joule/sec
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Note: Power = energy / unit time

**"Permeability" (hydraulic conductivity)** The hydraulic conductivity (K) depends on the density & dynamic viscosity of the fluid and the intrinsic permeability ( $K_i$ ) of the medium  $\{Q = -K A (dh/dl); K = K_i (\rho g) / \mu\}$ . K has dimensions of speed;  $K_i$  of area. For water at 15.6° C:

If K=1 m/sec, then...  $K_i = 1.161 \times 10^5$  Darcies  $K_i = 1.15 \times 10^{-3}$  cm<sup>2</sup>If  $K_i = 1$  Darcy, then...  $K = 8.61 \times 10^{-6}$  m/sec  $K_i = 9.87 \times 10^{-9}$  cm<sup>2</sup>

**Addendum**

Middleton, G.V. and P.R. Wilcock "Mechanics in the Earth and Environmental Sciences"

List of known corrections to First Printing  
(<http://www.science.mcmaster.ca/geo/mwcorrect.htm>)

p.49, unnumbered equation above (2.89): delete minus

p.49, lines 2-3 above bottom: delete sentence beginning "The new coordinates..."

p.81, in Equation (3.16) 6 *should be* 24, i.e.  $C_D = 24/Re$

p.106, line 23: certain *should be* shear

p.121, line 10: *should read* clockwise:  $\tau_{yx}(\delta x)^3$  anticlockwise:  $\tau_{xy}(\delta x)^3$  i.e., the gammas should be taus, and the exponent *should be* 3 not 2.

p.207, line 7: in the formula K *should be* (k/g)

p.289, line 1: grad *should be* div.

p.293, line 2 from bottom: RHS of equation  $\rho c_o^2/\lambda$  i.e., switch the numerator and divisor.

p.294, line 4-5: *should read* between the representative velocity and the speed of sound C, in the substance.

p.405, last line of Equation (12.21): RHS *should be* XY -bZ