



College of Science

Department of Earth Science and
Petroleum

Environmental Geology

By:

M.Rebaz & M.Hassan

MSc. Engineering Geology

MSc. Industrial Geology



Outline:

Soils and their Classification

Soils - What are they?

- Particulate materials
 - Sedimentary origins (usually)
 - Residual

- Wide range of particle sizes
 - larger particles: quartz, feldspar
 - very small particles: clay minerals

- Voids between particles

Simple Classification

- Usually soil on site has to be used.
 - Soils differ from other engineering materials in that one has little control over their properties
- Extent and properties of the soil have to be determined
- Cheap and simple tests are required to give an indication of engineering properties, e.g. stiffness, strength, for preliminary design



Classification based on Particle Size

- Particle size is used because it is related to mineralogy
 - e.g. very small particles usually contain clay minerals

- Broad Classification
 - Coarse grained soils
 - sands, gravels - visible to naked eye



Unified Soil Classification System (USCS)

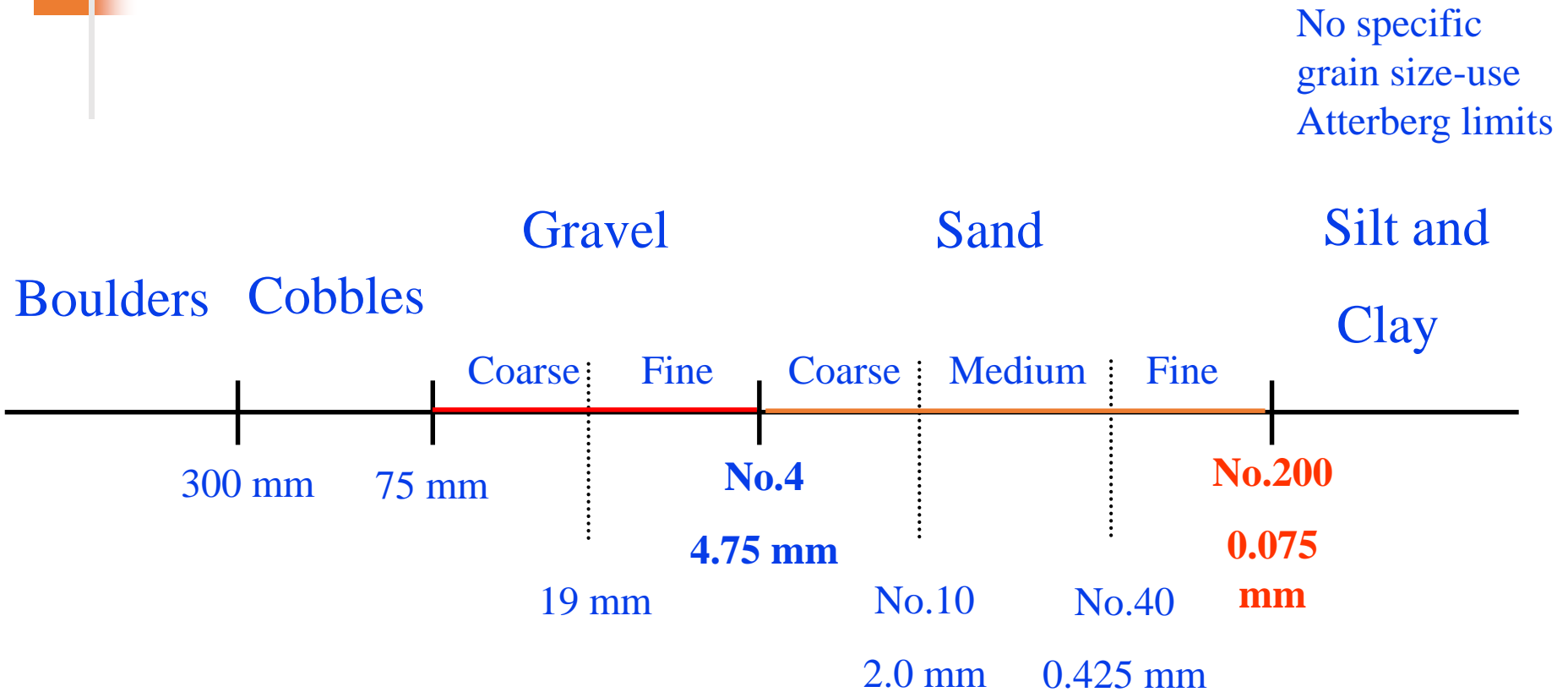
Origin of USCS:

This system was first developed by Professor A. Casagrande (1948) for the purpose of airfield construction during World War II. Afterwards, it was modified by Professor Casagrande, the U.S. Bureau of Reclamation, and the U.S. Army Corps of Engineers to enable the system to be applicable to dams, foundations, and other construction (Holtz and Kovacs, 1981).

Four major divisions:

- (1) Coarse-grained
- (2) Fine-grained
- (3) Organic soils
- (4) Peat

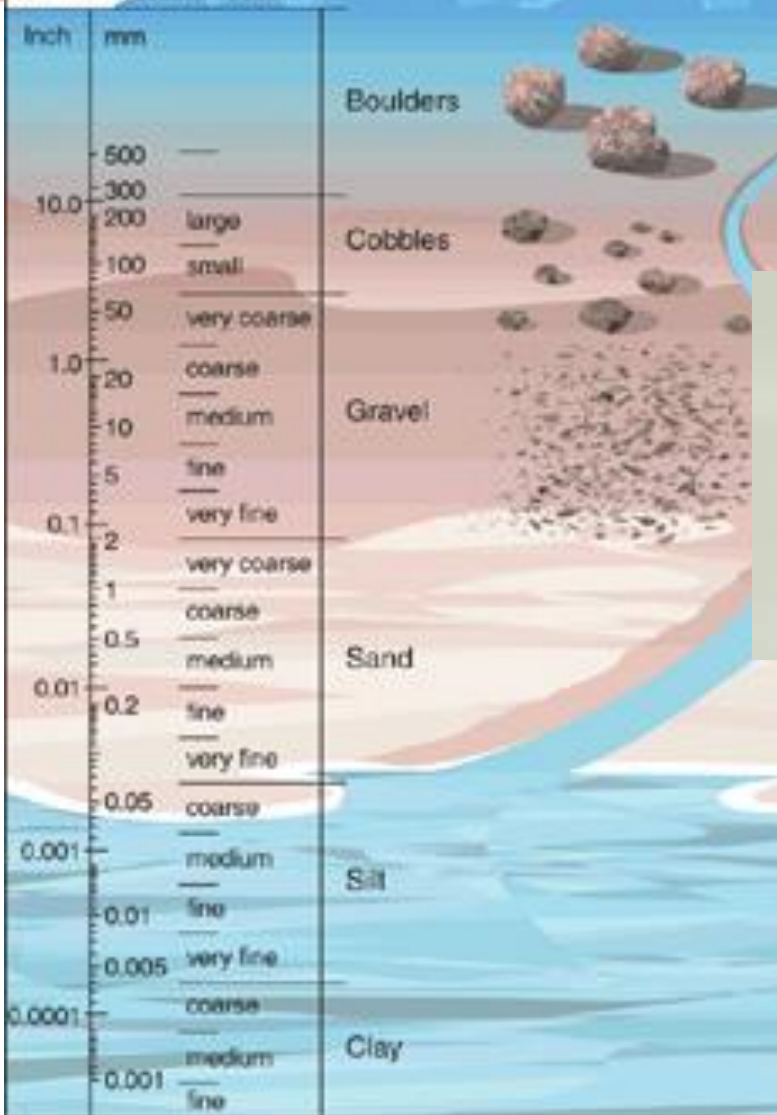
Definition of Grain Size



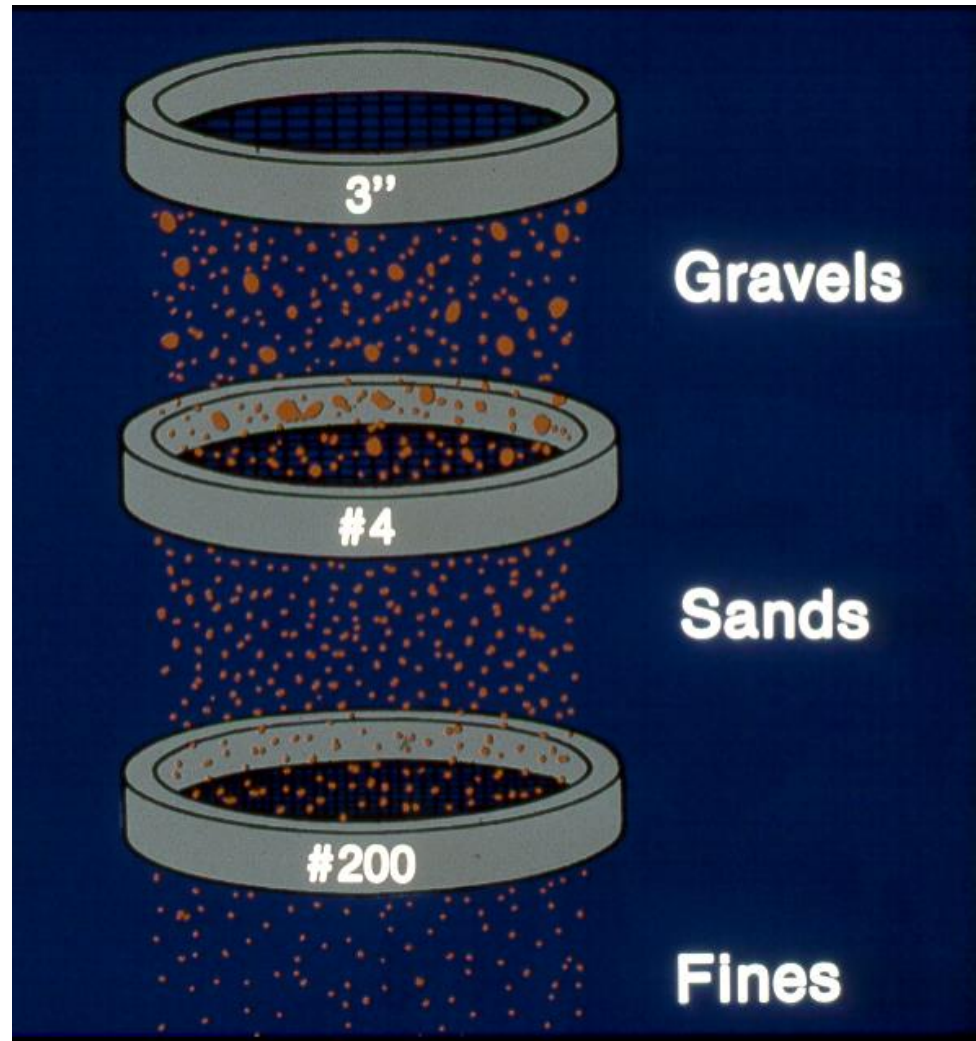
Soil Texture

Wentworth Scale

Udden-Wentworth Scale



Sieve Analyses



- For **coarse-grained soils (gravel and sand)**, determine the percent passing the #10, 40, and 200 sieves.

3 “

#10

#40

#200



Definitions

□ Particle Sizes

- Gradation or Mechanical Analyses
- Sieves for larger particles
- Hydrometer for fine particles



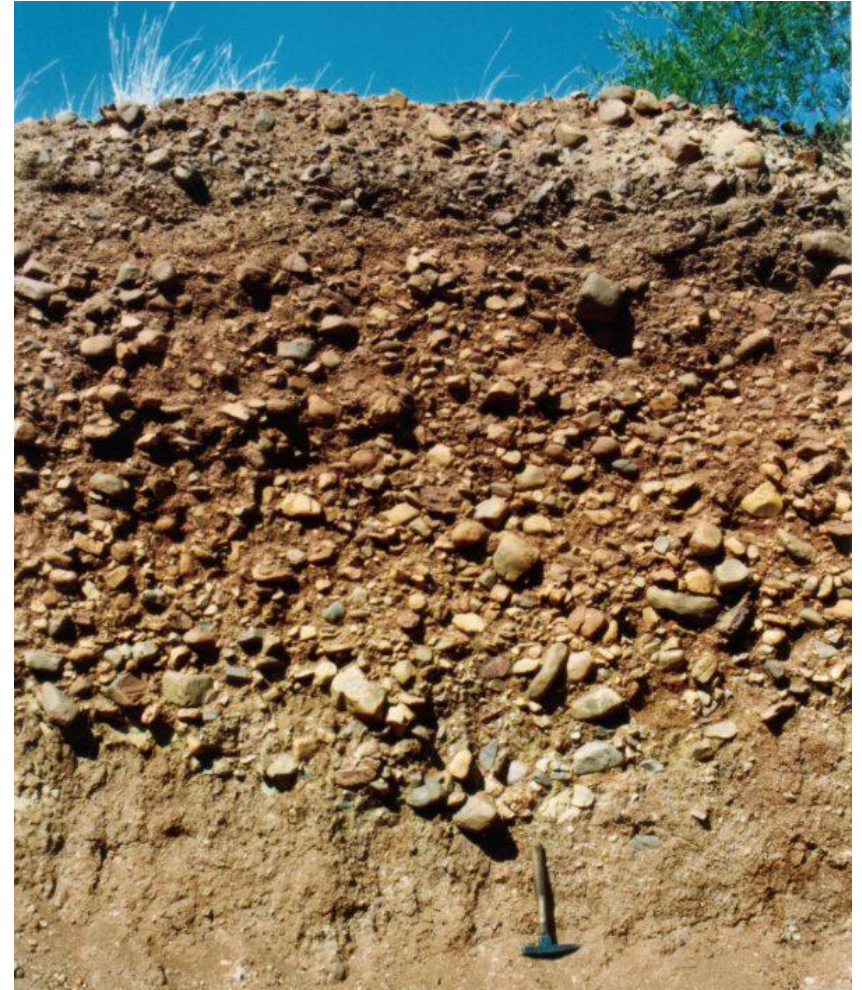
Typical GC soil - glacial till

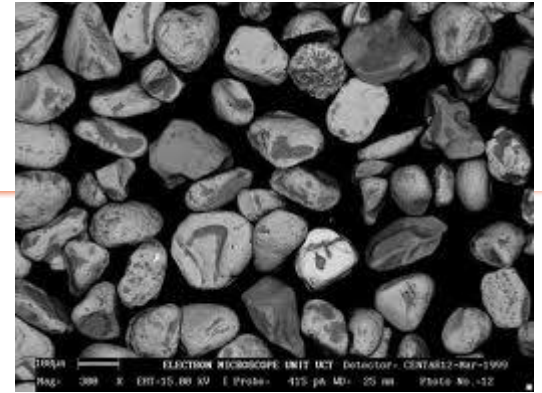
Gravel with
matrix of clay



Typical GM soil - Alluvium

Gravel with
matrix of
silt





Soil Classification Symbols

Prefix

Grain size symbols:

G: Gravel

S: Sand

M: Silt

C: Clay

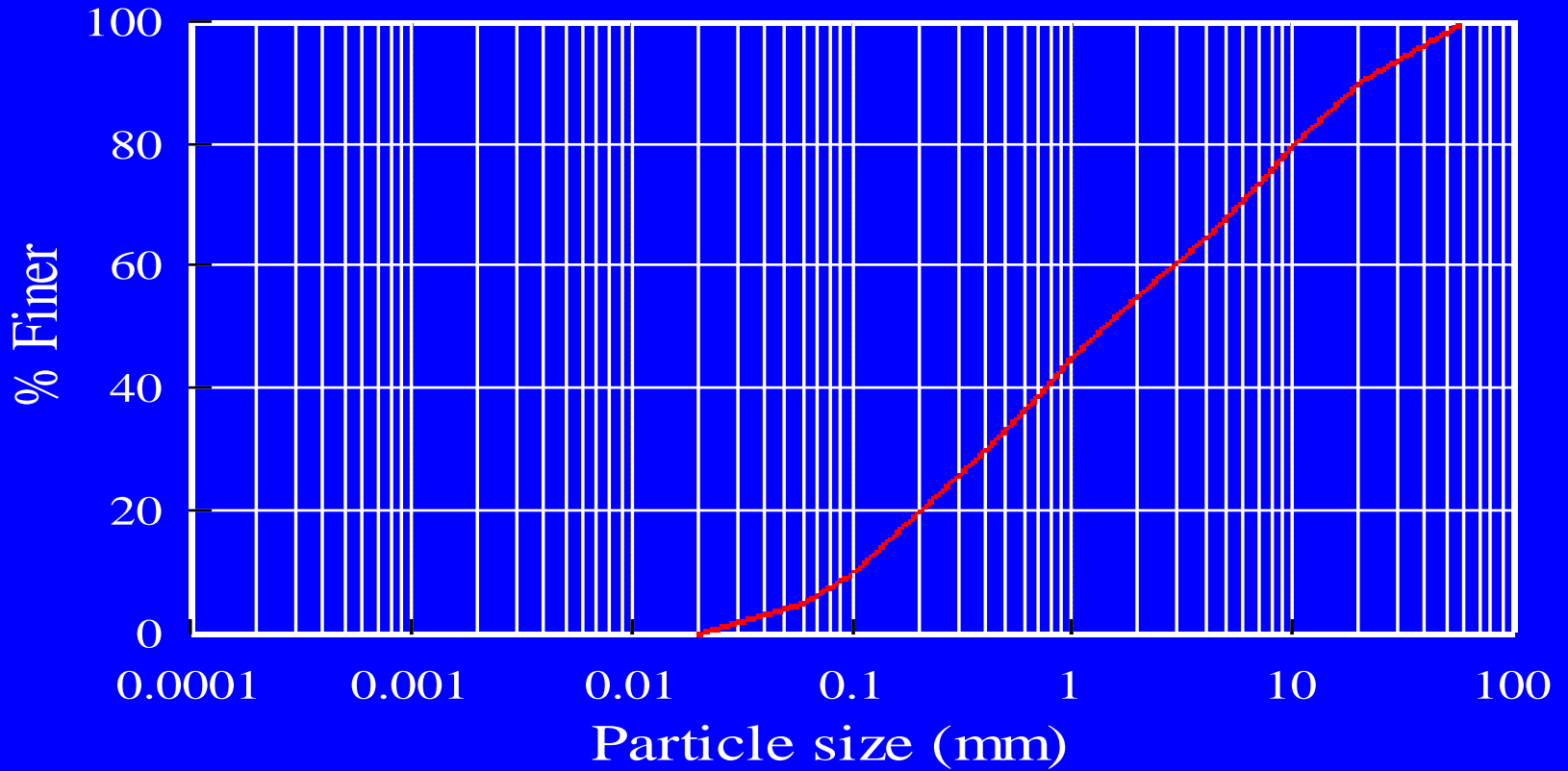
Suffix

Gradation symbols:

W: Well-graded

P: Poorly-graded

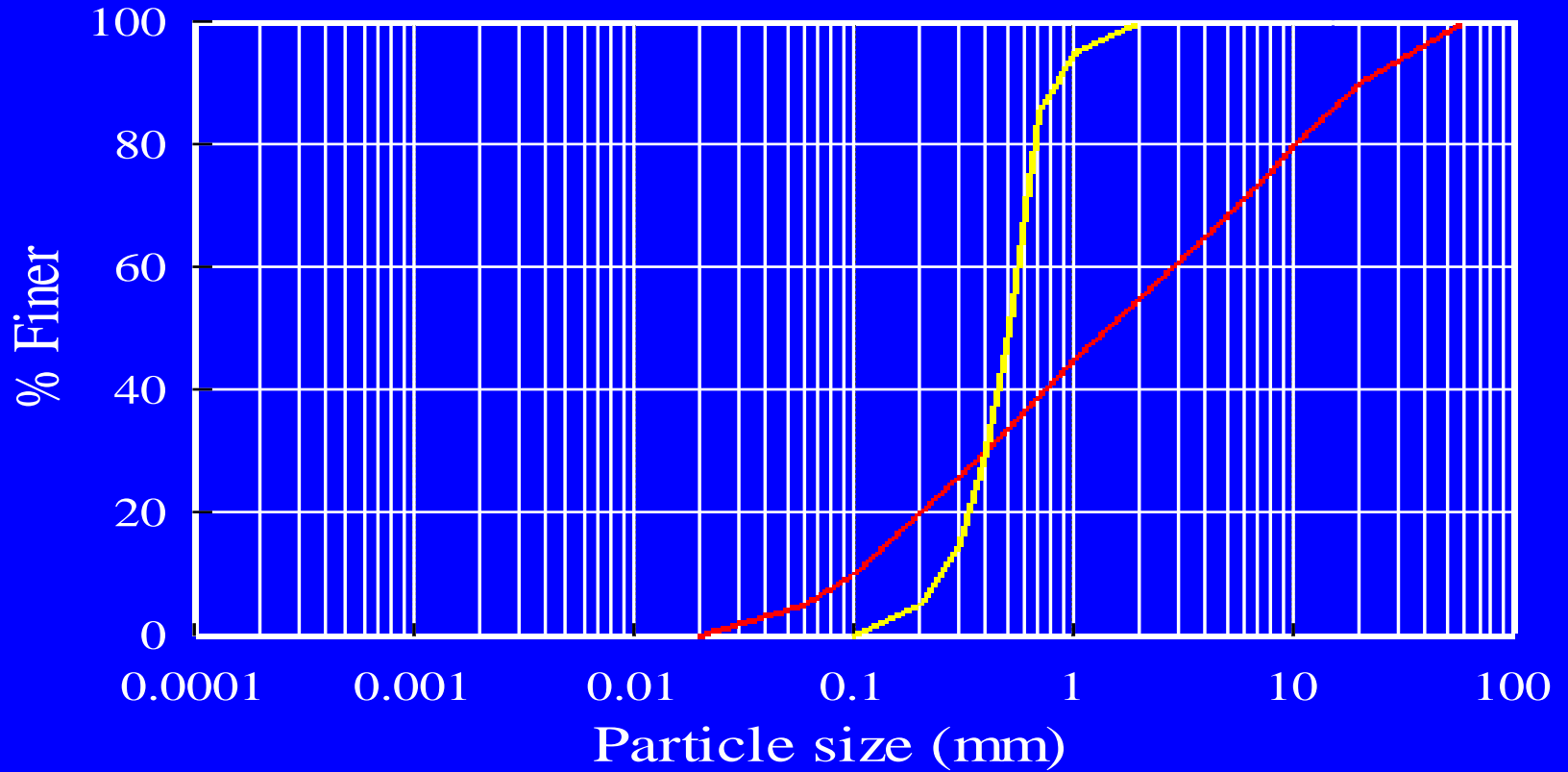
Grading curves



W

Well graded

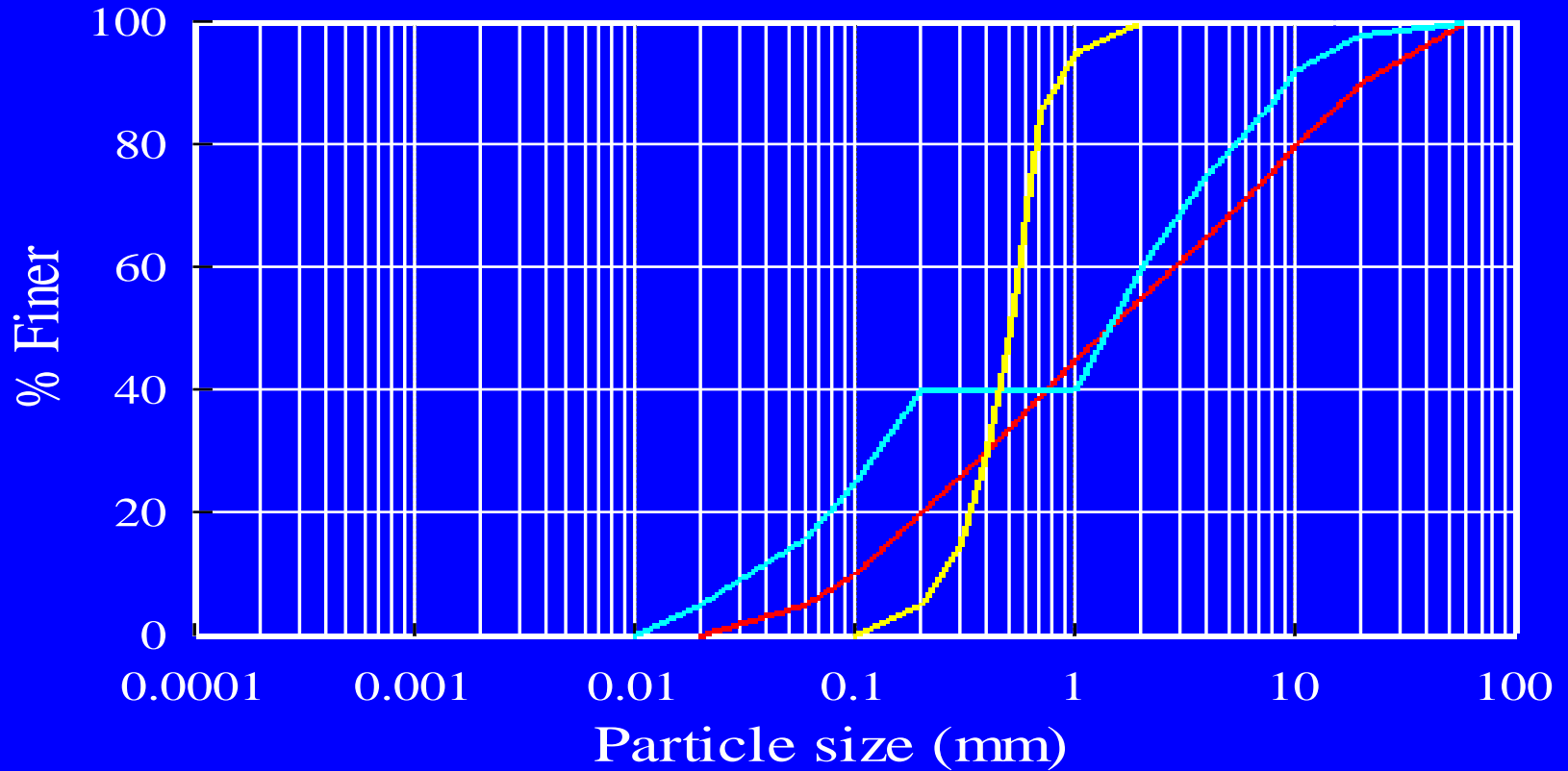
Grading curves



W Well graded

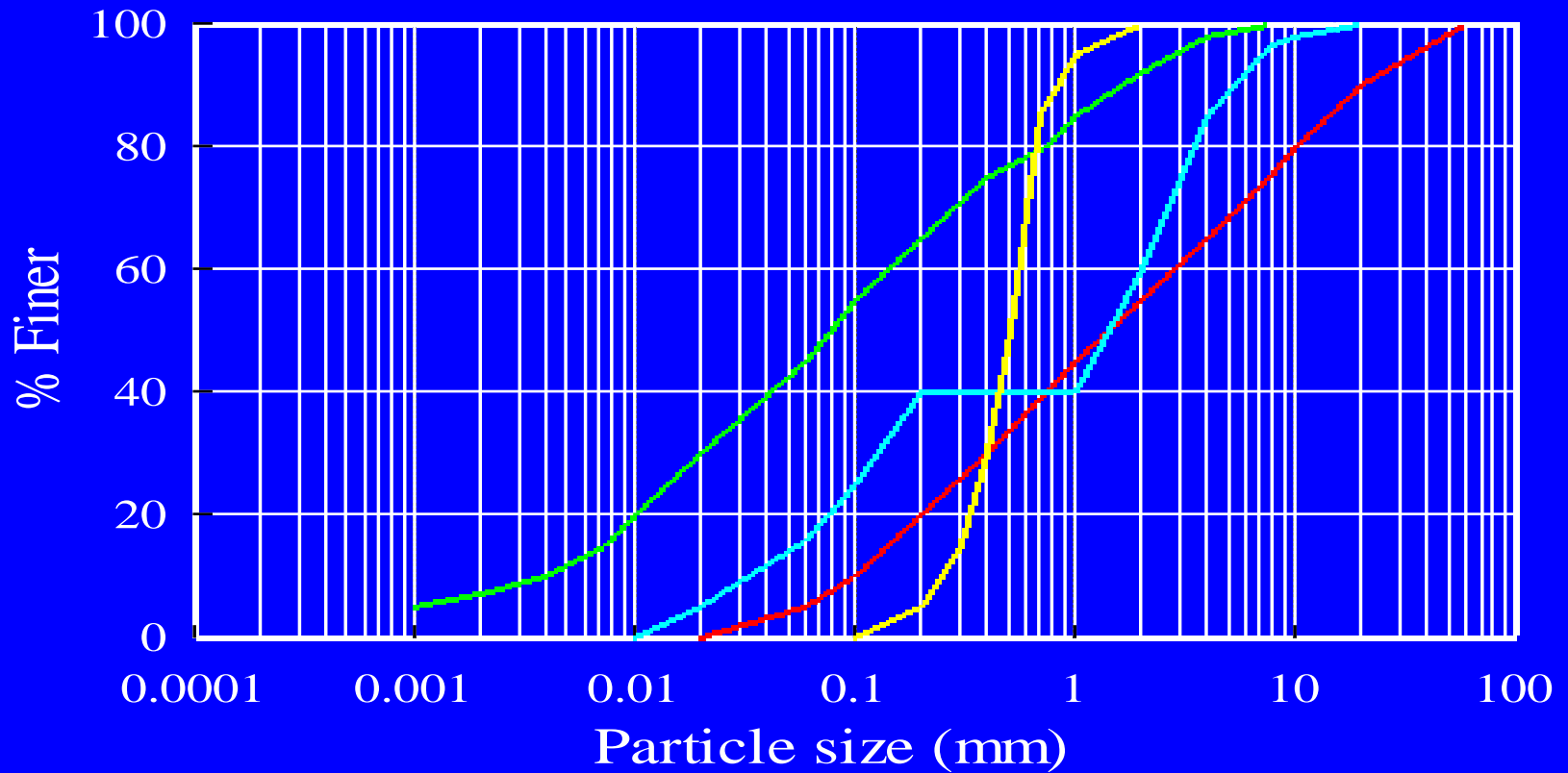
U Uniform

Grading curves



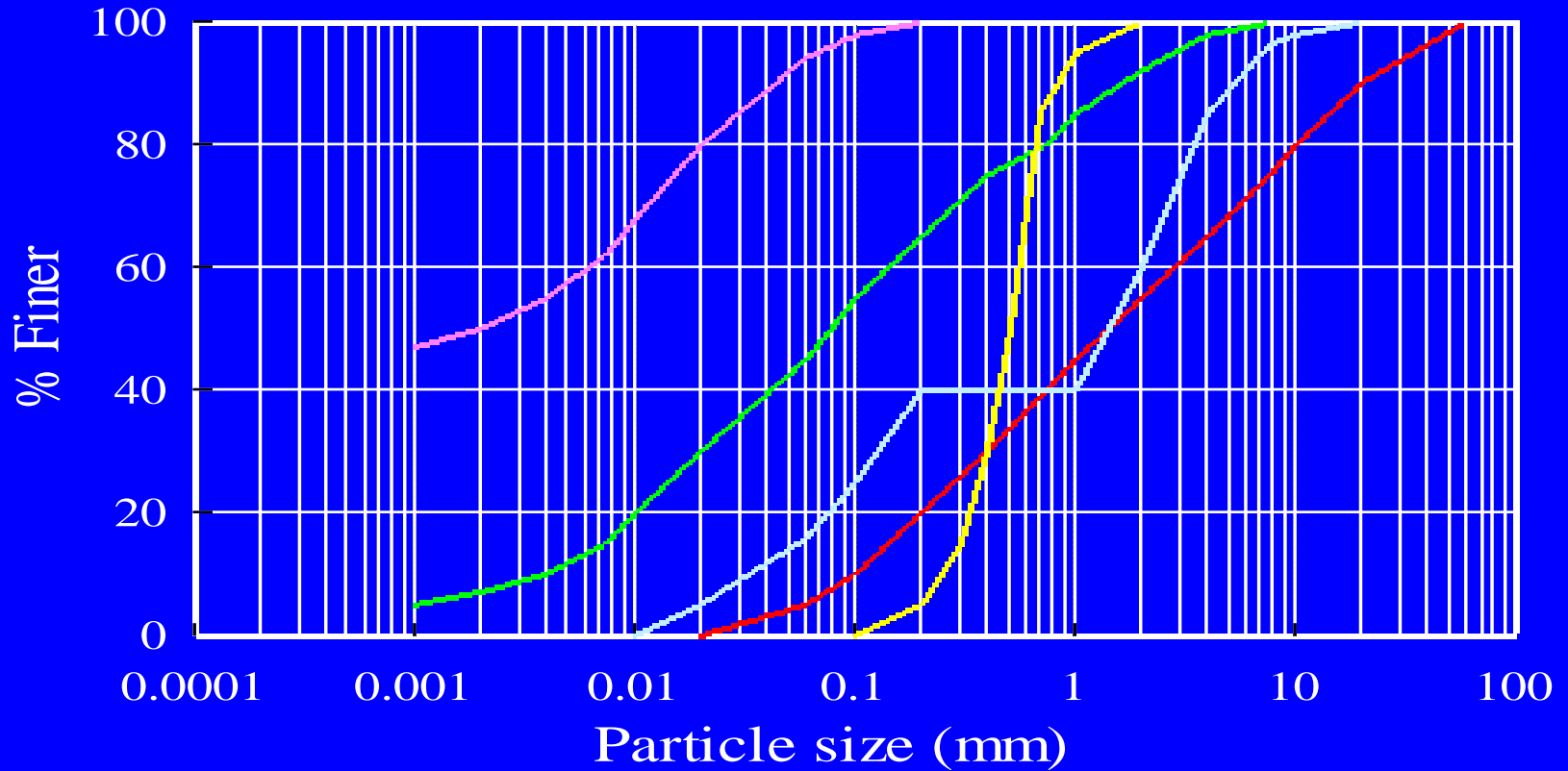
- W Well graded
- U Uniform
- P Poorly graded

Grading curves



- W Well graded
- U Uniform
- P Poorly graded
- C Well graded with some clay

Grading curves



- W Well graded
- U Uniform
- P Poorly graded
- C Well graded with some clay
- F Well graded with an excess of fines

Sieve analysis

- Gravel: C_u greater than 4 and C_c in a range between 1 and 3 well graded
- Sand: C_u greater than 6 and C_c in a range between 1 and 3 are well graded
- C_u less than 2 is Uniform graded
- Otherwise the soil is poorly graded

- If both criteria are not met the soil become poorly graded



Any Question