Welded Tuff

References:

Smith, RL, 1960, Zones and zonal variations *in* welded ash flows. USGS Prof. Paper 354F, pp. 149-159

Ragan, DM and Sheridan, MF, 1972, Compaction of the Bishop Tuff, California. Geol. Soc. America Bull., 83:95-106

Lecture Topics

- Emplacement characteristics
- Cooling process
- Welding process
- Secondary crystallization

Emplacement Stages

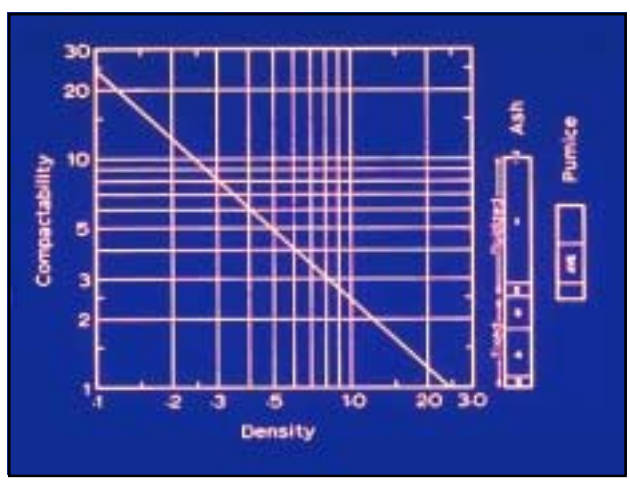
- Deflation
- Degassing
- Mechanical compaction
- Welding compaction
- Equal volume deformation

Basic Parameters

- Solid fraction (G)
- Pore fraction (ϕ)
- Density (ρ)
- Powder density (ρ_p)

Physical Properties

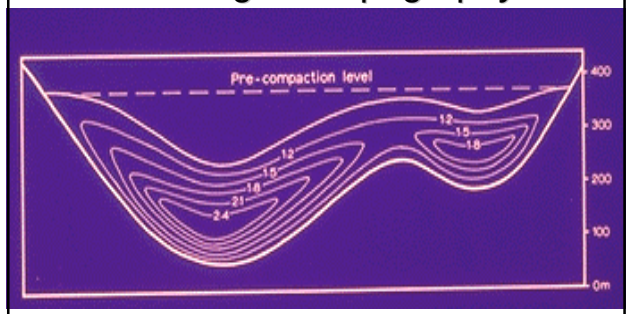
	ϕ	ρ
Before deflation	.90	.25
Before degassing	.65	.86
Loose packing	.60	1.00
Partly welded	.45	1.35
Densely welded	.10	2.20
Completely welded	.00	2.45



Bulk Parameters

- ρ_b is a good measure of strain
- ρ_b = 1.0 for non-welded ash
- ρ_b = 2.45 for complete welding
- Compaction profiles record bulk strain

Welding on Topography



Calculated Parameters

- Bulk density (ρ_b)

  $\rho_B = G * \rho_p$

- Bulk pore fraction (ϕ_b)

  $\phi_b = 1.0 - G = (\rho_p - \rho_b)/\rho_p$

- Bulk strain (ε)

  $\varepsilon = \Delta l/l = \rho_b$

Calculations from Profiles

Mathematical description of the profile

$$h = \sum_{x=1}^{n} f(x)\, dx$$

In discrete form:

$$h = \sum_{x=1}^{n} f(x)\, \Delta x$$

Emplacement Thickness

ρ_b = 1.0 g/cm

f (x) = ρ_b

$$h_e = \sum_{x=1}^{n} \rho_b\, \Delta x$$

Total compaction = $h_e - h$

Solid Equivalent Thickness

ρ_b = 2.45 g/cm^3

f (x) = ρ_b / ρ_p

$$h_s = \sum_{x=1}^{n} \rho_b / \rho_p\, \Delta x$$

Strain Gauges

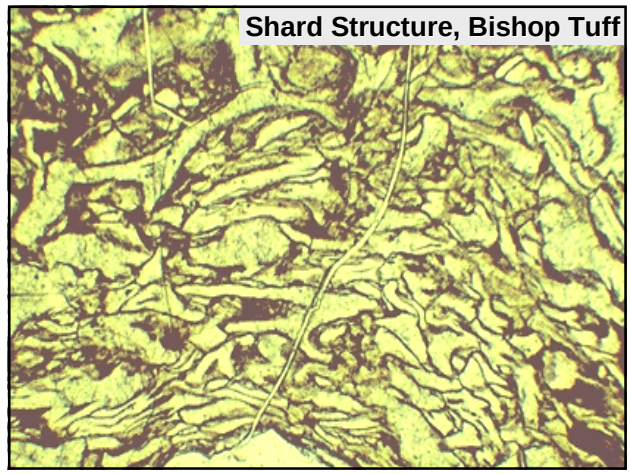
- Circular bubbles
- 3-pronged shards
- Pumice shape ratio (r_f)

$$[r_f] = [r_i] * [r_s]$$

Lithic clasts are rigid

- Strain shadow zones

Shard Structure, Bishop Tuff



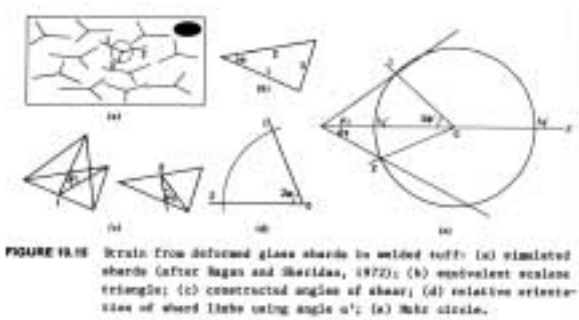


FIGURE 10.16 Strain from deformed glass shards in welded tuff: (a) simulated shards (after Ragan and Sheridan, 1972); (b) equivalent scalene triangle; (c) constructed angles of shear; (d) relative orientation of shard limbs using angle α'; (e) Mohr circle.

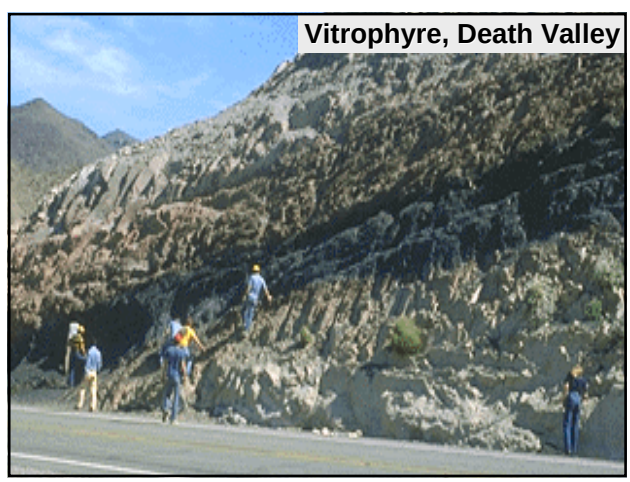
Tuff Strain is Inhomogeneous

- Comparison of pumice and ash
- Rigid bodies
- Poison's ratio
- Effect of buried topography
- Effect of overburden on strain rate

Welding Profiles

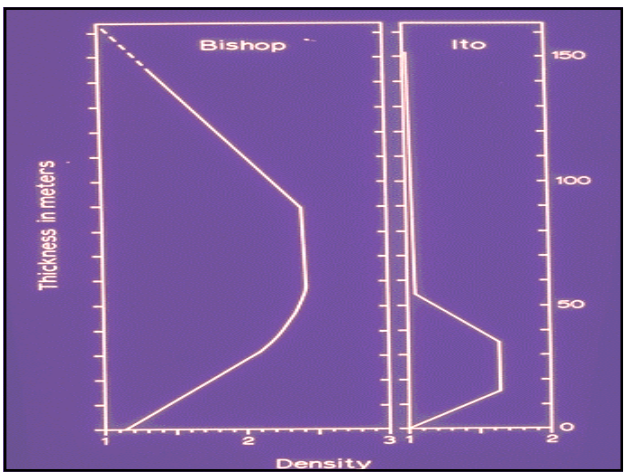
- Density plotted vs. elevation
  - Assume $\rho = 1000$ kg/m^3 at base and top
  - ρ = maximum value near center
- Erosion easily removes upper part
- Welding = f (T, P)

Vitrophyre, Death Valley



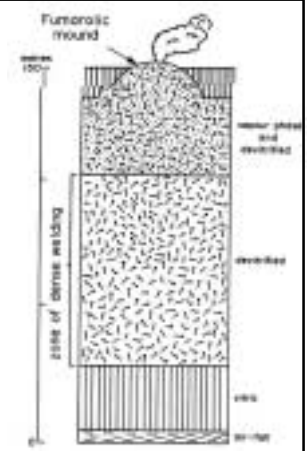
Partly Welded Bishop Tuff

Vitrophyre, Armenia



Secondary Crystallization

- Devitrification
- Fumarolic crystallization
- Vapor-phase crystallization
- Granophyric crystallization



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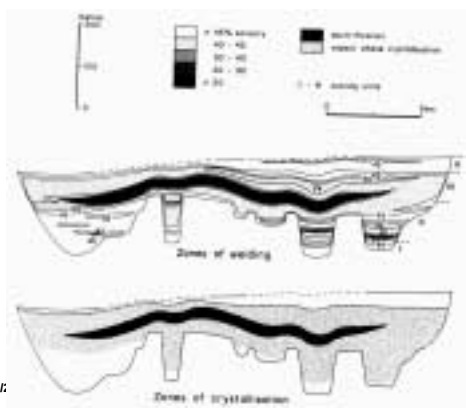
Bandelier Tuff Welding and Crystallization



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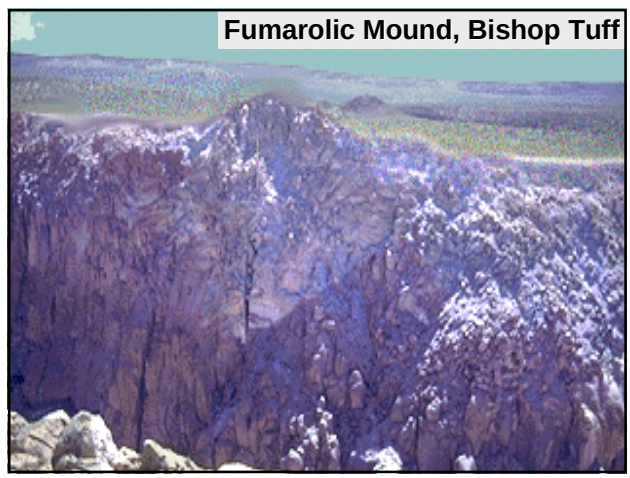
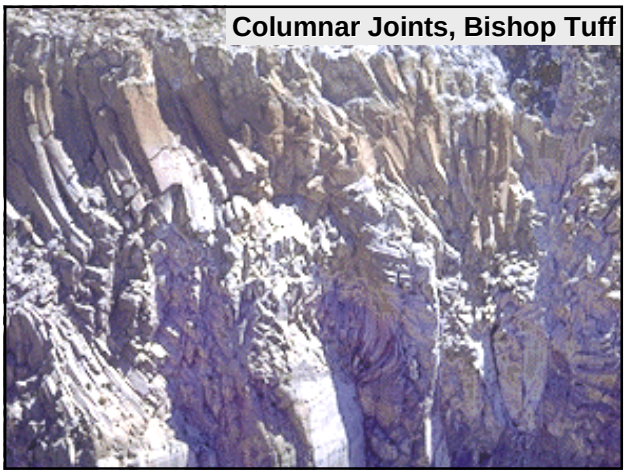
Fumarolic Mound, Bishop Tuff




Columnar Joints, Bishop Tuff