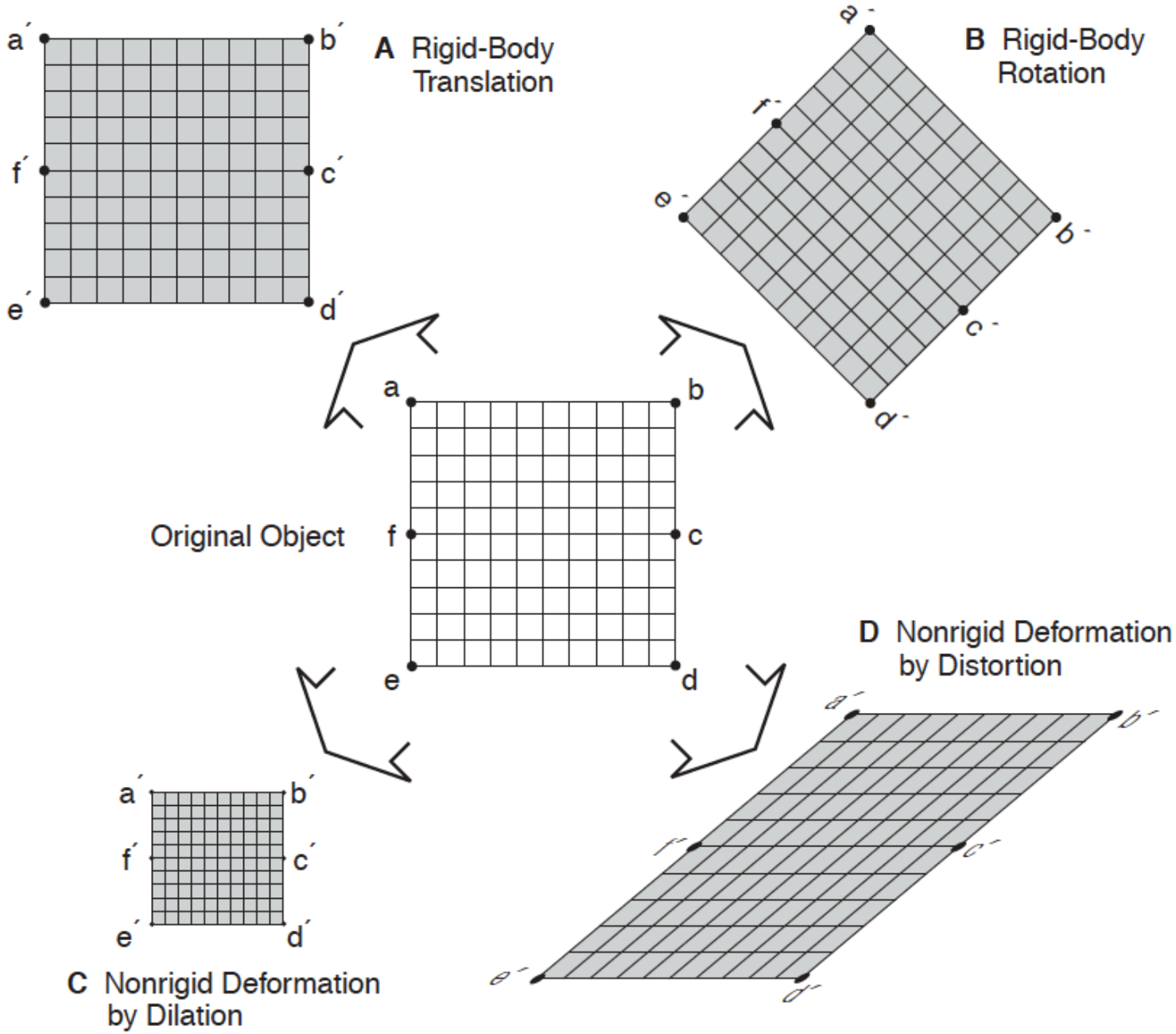

# Deformasyon kavramı
# Gerilme deformasyon ilişkisi
# Deformasyonu etkileyen faktörler

KAYA KÜTLESİNİN YERİNDE, ŞEKLİNDE, KONUMUNDA VE HACMİNDE MEYDANA GELEN DEĞİŞİKLER DEFORMASYON OLARAK TANIMLANMAKTADIR.

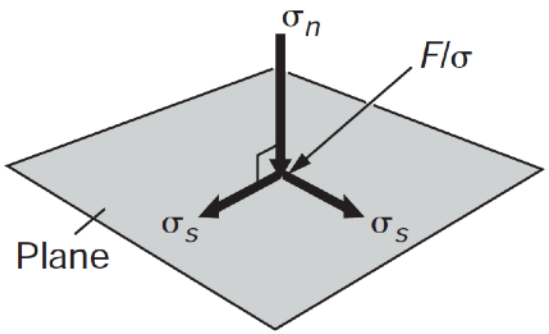
Deformation is the transformation from an initial to a final geometry by means of rigid body translation, rigid body rotation, strain (distortion) and/or volume change.



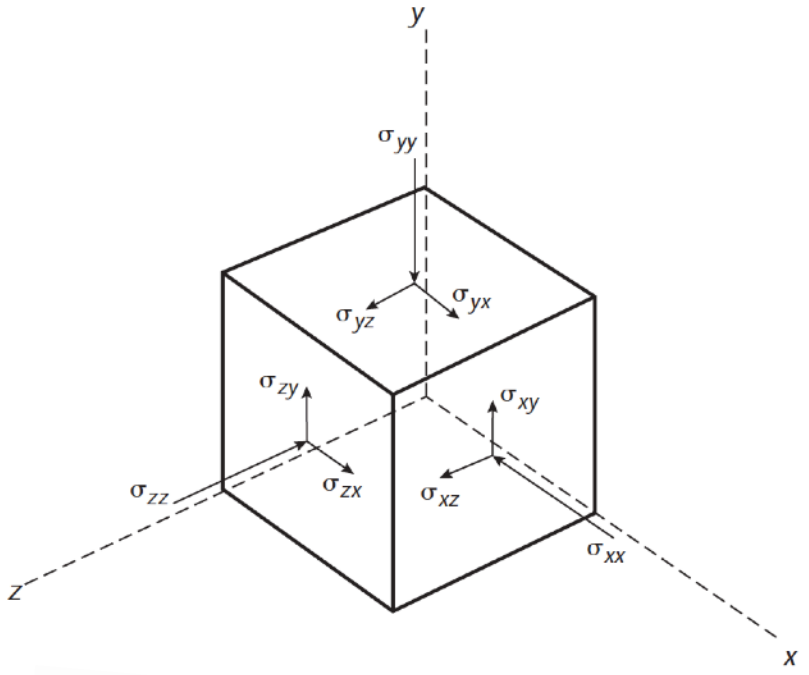


A Rigid-Body Translation
B Rigid-Body Rotation
Original Object
C Nonrigid Deformation by Dilation
D Nonrigid Deformation by Distortion

# GERİLME

$$\sigma = F/A$$




$\sigma_n$ is normal stress
$\sigma_s$ is shear stress
$F$ is force; $\sigma$ is stress

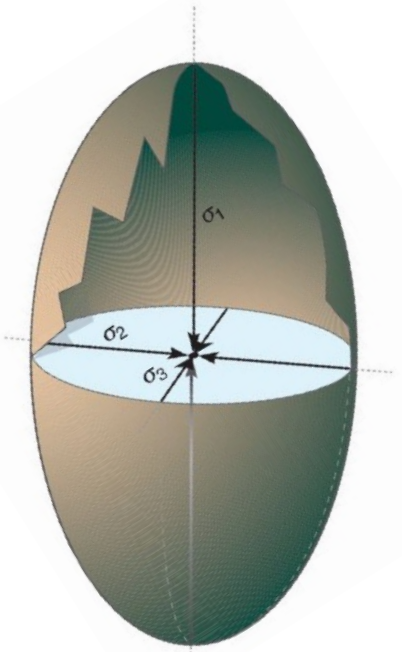



$$\begin{pmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ \tau_{yx} & \sigma_{yy} & \tau_{yz} \\ \tau_{zx} & \tau_{zy} & \sigma_{zz} \end{pmatrix}.$$

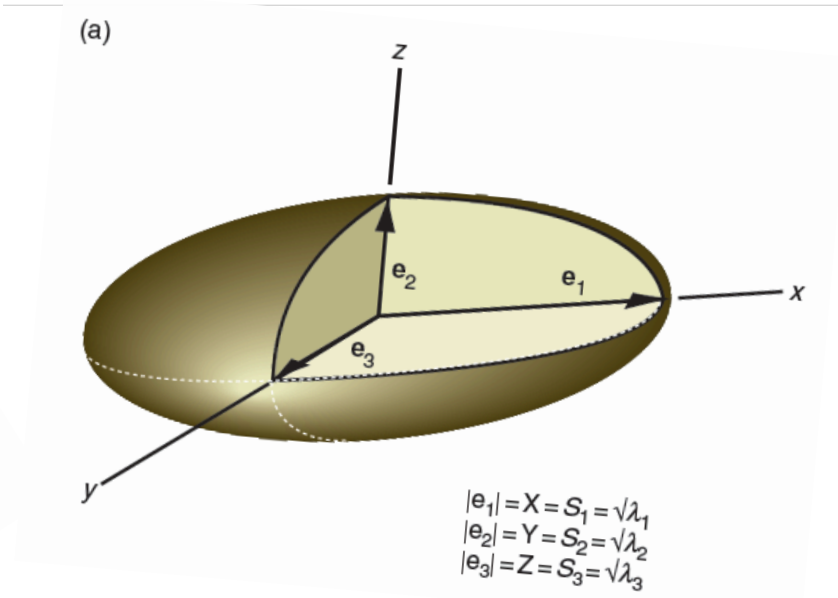
$$\begin{pmatrix} \sigma_{xx} & 0 & 0 \\ 0 & \sigma_{yy} & 0 \\ 0 & 0 & \sigma_{zz} \end{pmatrix}.$$

Asal Gerilme Eksenleri
$\sigma 1 > \sigma 2 > \sigma 3$
ve birbirine diktir

GERİLME ELİPSOİDİ




ASAL GERİLME EKSENLERİ



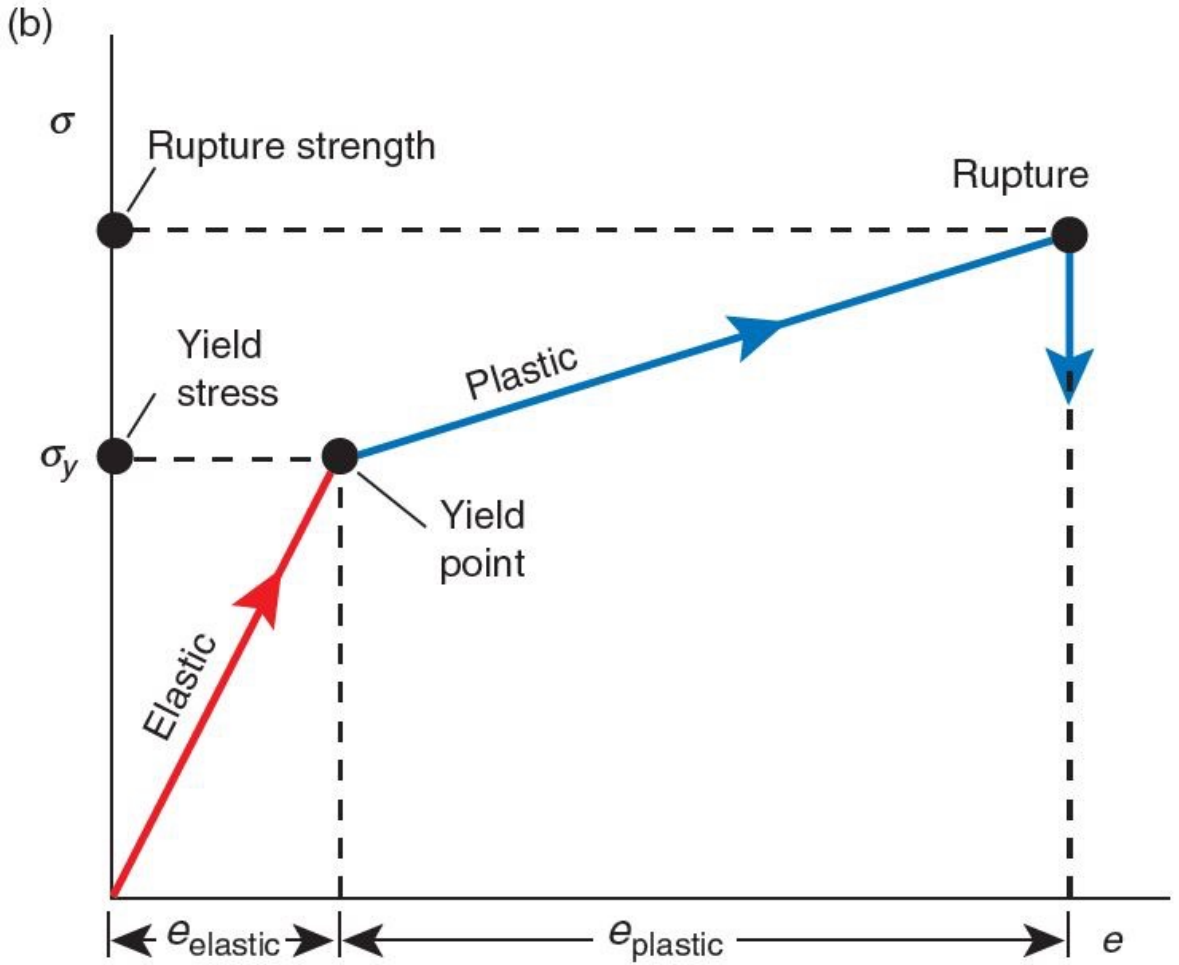
# DEFORMASYON

**ELASTİK**
**KALICI OLMAYAN**

DEPREM DALGALARININ
YER KABUĞUNDA YAYILMASI

**PLASTİK**
**KALICI OLAN**

KAYALARDA GÖZLENEN İKİNCİL
YAPILAR




**Hooke Yasası**

## DEFORMASYONUN KAYA KÜTLESİ İÇİNDE DAĞILIMINA GÖRE SINIFLANMASI

**SÜREKLİ**: KAYA KÜTLESİ İÇİNDE HER ÖLÇEKTE GÖZLENİR

**PENETRATİF**: GÖZLEM ÖLÇEĞİNDE KAYA KÜTLESİNİN HER YERİNDE BULUNUR; YAKINLAŞTIKÇA YAPILAR ARASI MESAFE BULUNABİLİR.

**LOKALİZE**: SÜREKLİ VEYA PENETRATİF YAPI BELİRLİ BİR ALANDA BULUNURSA

**AYRIK**: YAPI DİĞERLERİNDEN AYRI OLARAK BULUNUR

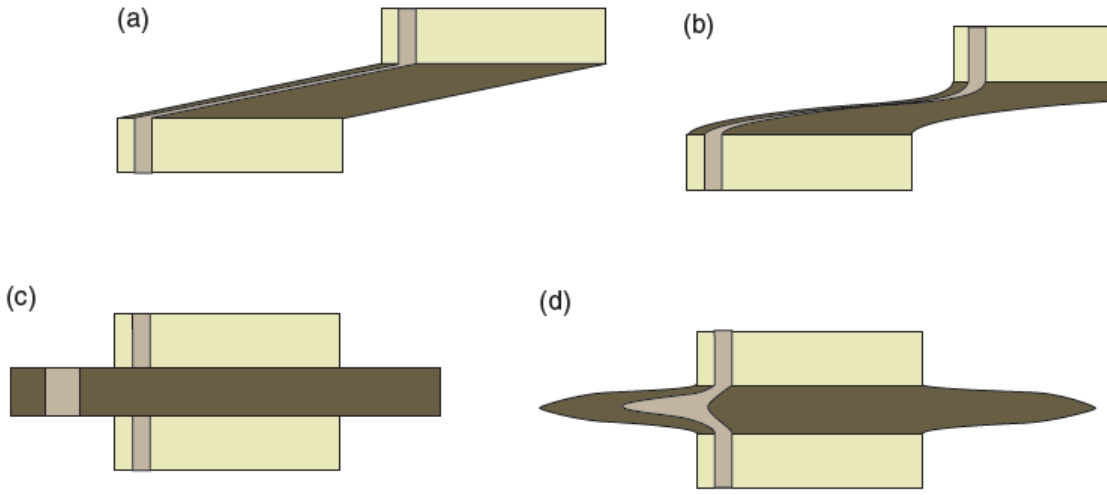
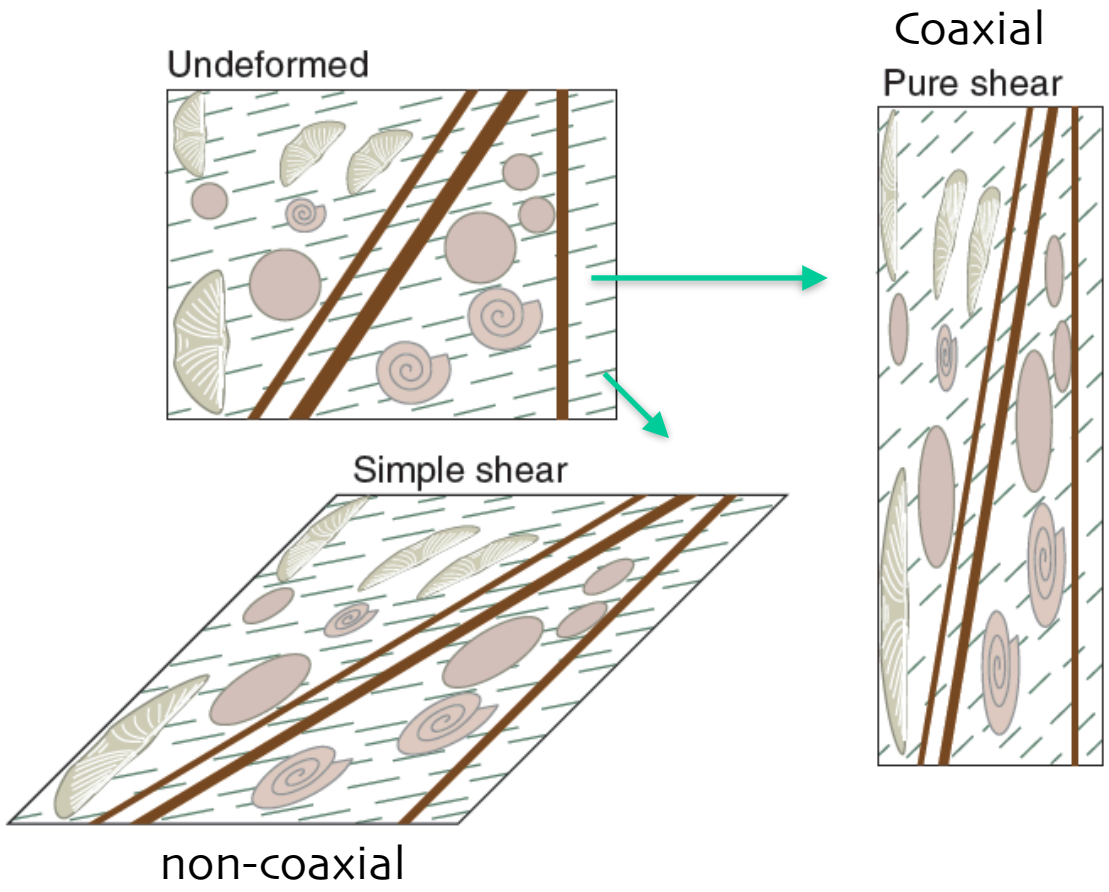



**Figure 2.25** Homogeneous (a) and heterogeneous (b) simple shear create no compatibility problems between the deformed and undeformed rocks. Homogeneous pure shear (c) does, because lateral extrusion of material creates discontinuities. The space problem is also apparent for heterogeneous pure shear (d), but the discontinuities can be eliminated.

**Homogeneous deformation: Straight lines remain straight, parallel lines remain parallel, and identically shaped and oriented objects will also be identically shaped and oriented after the deformation.**



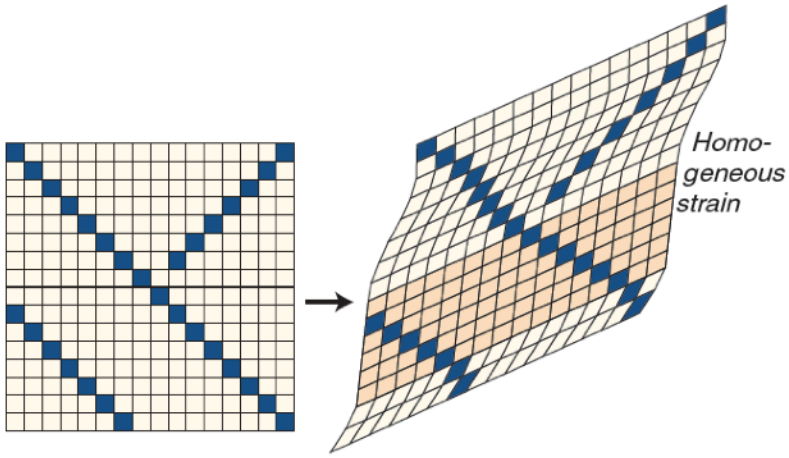




**Figure 2.5** A regular grid in undeformed and deformed state. The overall strain is heterogeneous, so that some of the straight lines have become curved. However, in a restricted portion of the grid, the strain is homogeneous. In this case the strain is also homogeneous at the scale of a grid cell.

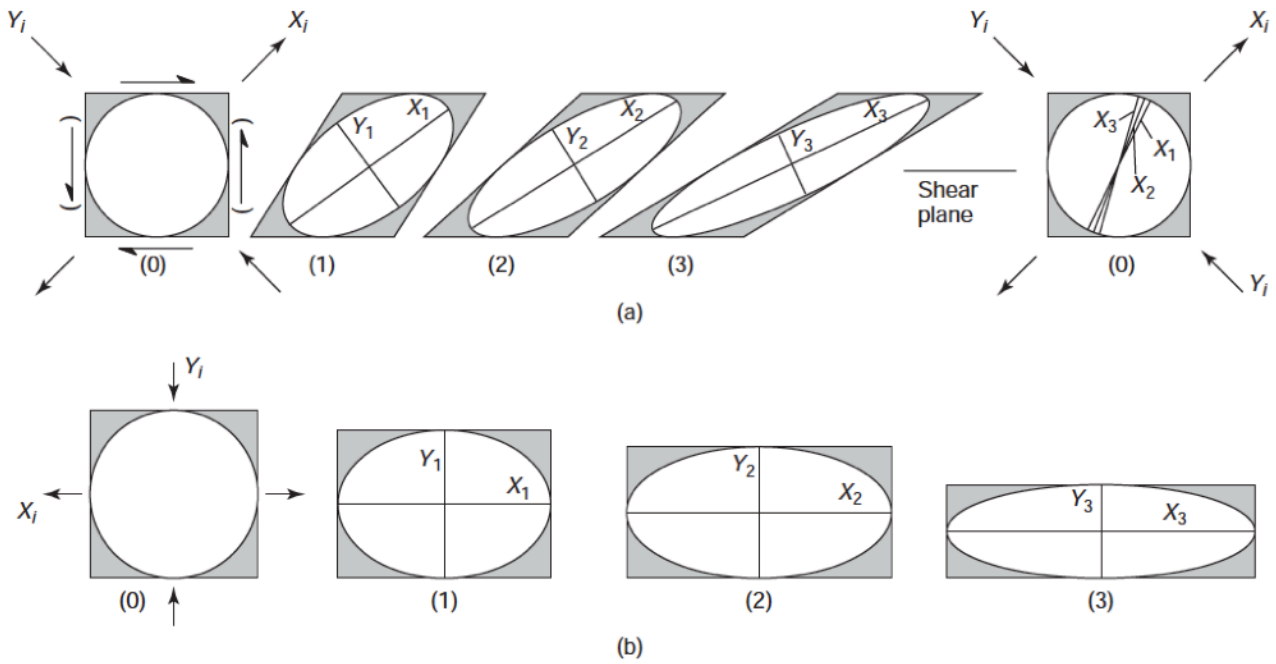
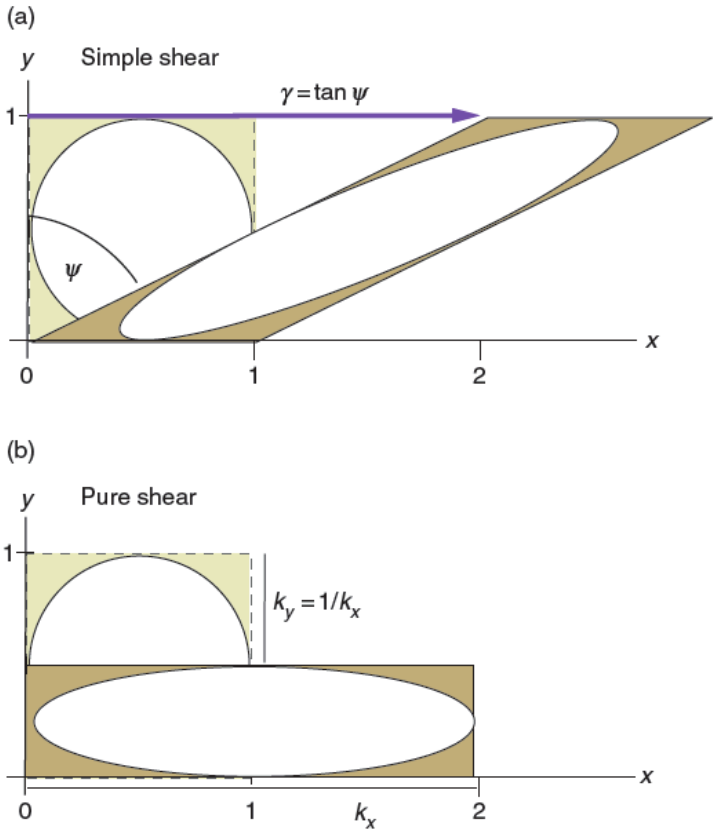
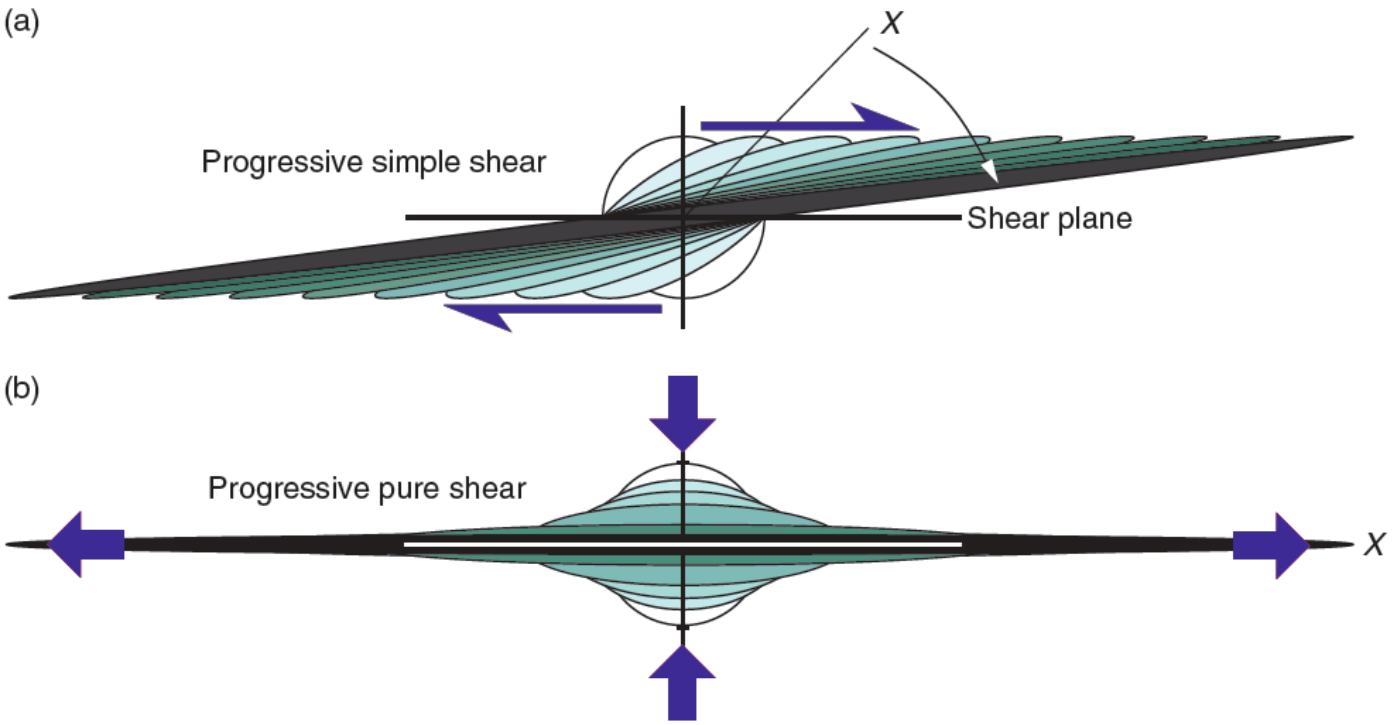



**FIGURE 4.6** Non-coaxial (a) and coaxial (b) strain. The incremental strain axes are different material lines during non-coaxial strain. In coaxial strain the incremental strain axes are parallel to the same material lines. Note that the magnitude of the strain axes changes with each step.






The evolution of strain during progressive simple and pure shear.

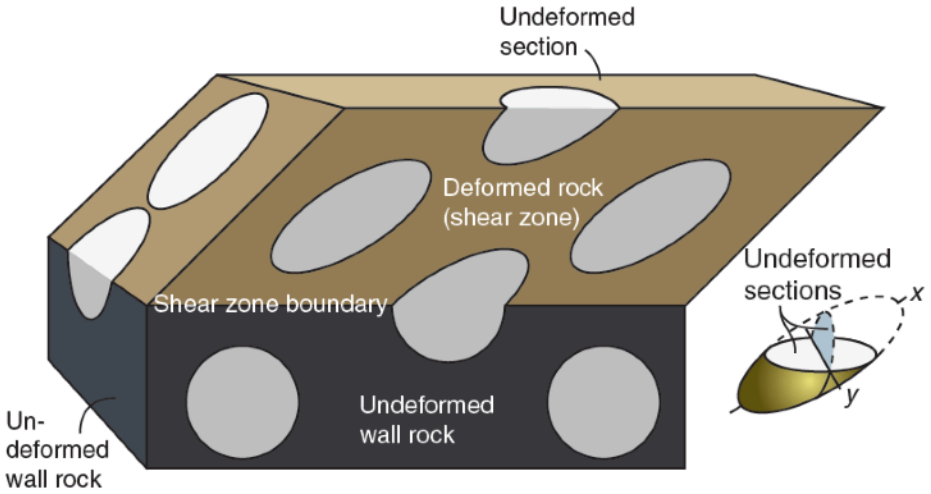
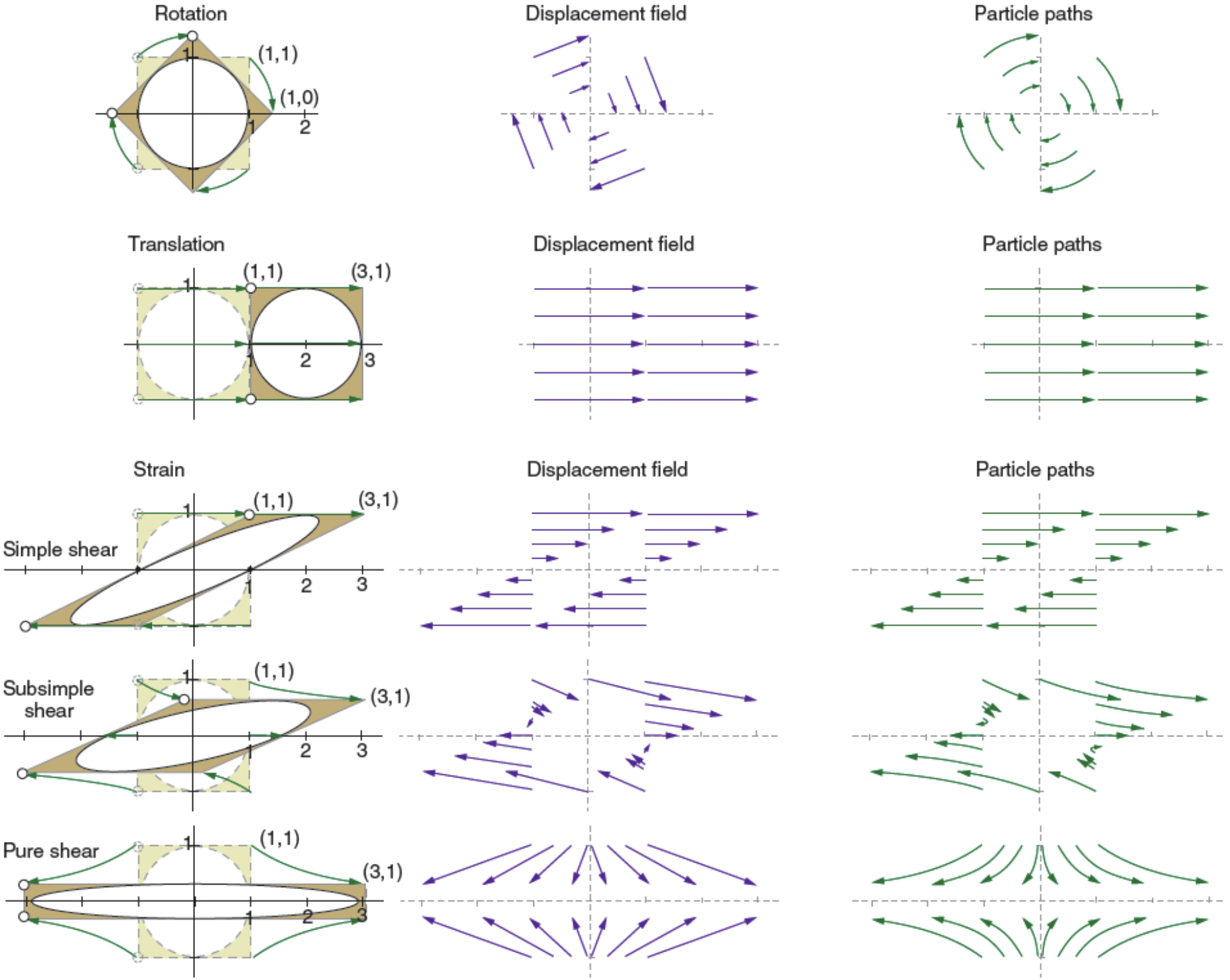



**Figure 2.26** The compatibility between undeformed wall rock and a simple shear zone. Any section parallel to the shear zone wall will appear undeformed.


Rotation
Displacement field
Particle paths
(1,1)
(1,0)
Translation
Displacement field
Particle paths
(1,1)
(3,1)
Strain
Displacement field
Particle paths
Simple shear
(1,1)
(3,1)
Subsimple shear
(1,1)
(3,1)
Pure shear
(1,1)
(3,1)

# Deformasyonu etkileyen faktörler

KAYA TÜRÜ (LİTOLOJİ)

ÇEVRE BASINCI

GÖZENEK SIVILARI BASINCI

GERİLME MİKTARI

GERİLMENİN UYGULANMA ŞEKLİ

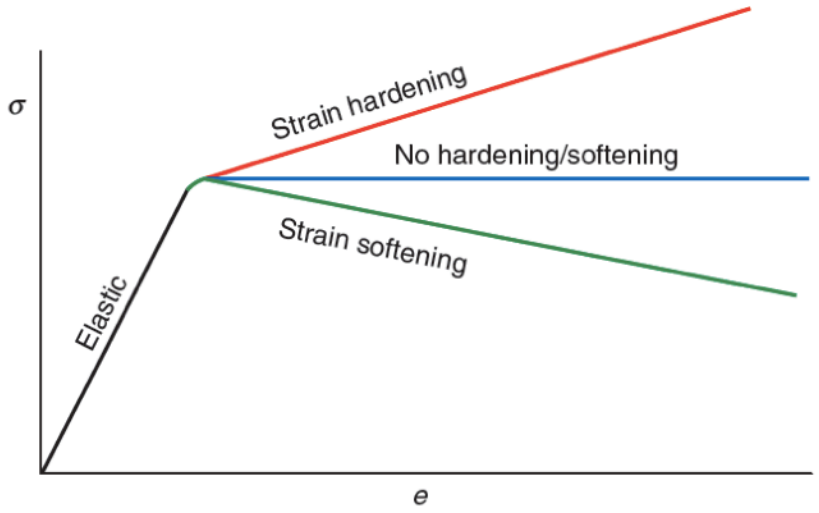
DEFORMASYON ORANI

ZAMAN

SICAKLIK

VAR OLAN SÜREKSİZLİKLERİN KONUMU

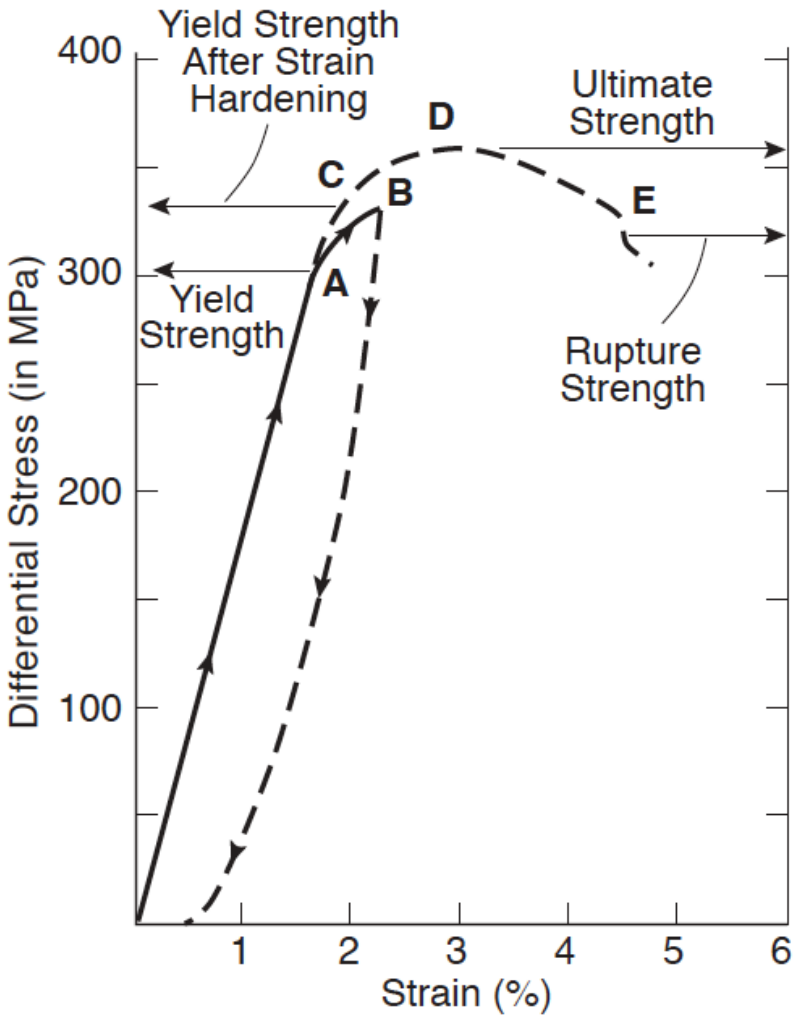
# GERİLME - DEFORMASYON EĞRİLERİ




Strain hardening means that the stress necessary to deform the rock must be increased for strain to accumulate, because the rock becomes stronger and harder to deform.

**Table 6.1** Representative values of Young's modulus *(E)* and Poisson's ratio *(v)* for some rocks, minerals and familiar media

| Medium | *E* (GPa) | *v* (Poisson's ratio) |
|---|---|---|
| Iron | 196 | 0.29 |
| Rubber | 0.01–0.1 | almost 0.5 |
| Quartz | 72 | 0.16 |
| Salt | 40 | ~0.38 |
| Diamond | 1050–1200 | 0.2 |
| Limestone | 80 | 0.15–0.3 |
| Sandstone | 10–20 | 0.21–0.38 |
| Shale | 5–70 | 0.03–0.4 |
| Gabbro | 50–100 | 0.2–0.4 |
| Granite | ~50 | 0.1–0.25 |
| Amphibolite | 50–110 | 0.1–0.33 |
| Marble | 50–70 | 0.06–0.25 |




YOUNG MODÜLÜ
ELASTİSİTE MODÜLÜ

KAYA TÜRÜ

General ranking of lithology according to strength, based on tests at room temperature and low confining pressure

| | |
|---|---|
| Strongest | Quartzite |
| | Granite |
| | Quartz-cemented sandstone |
| | Basalt |
| | Limestone |
| | Calcite-cemented sandstone |
| | Schist |
| | Marble |
| | Shale/mudstone |
| | Anhydrite |
| Weakest | Salt |

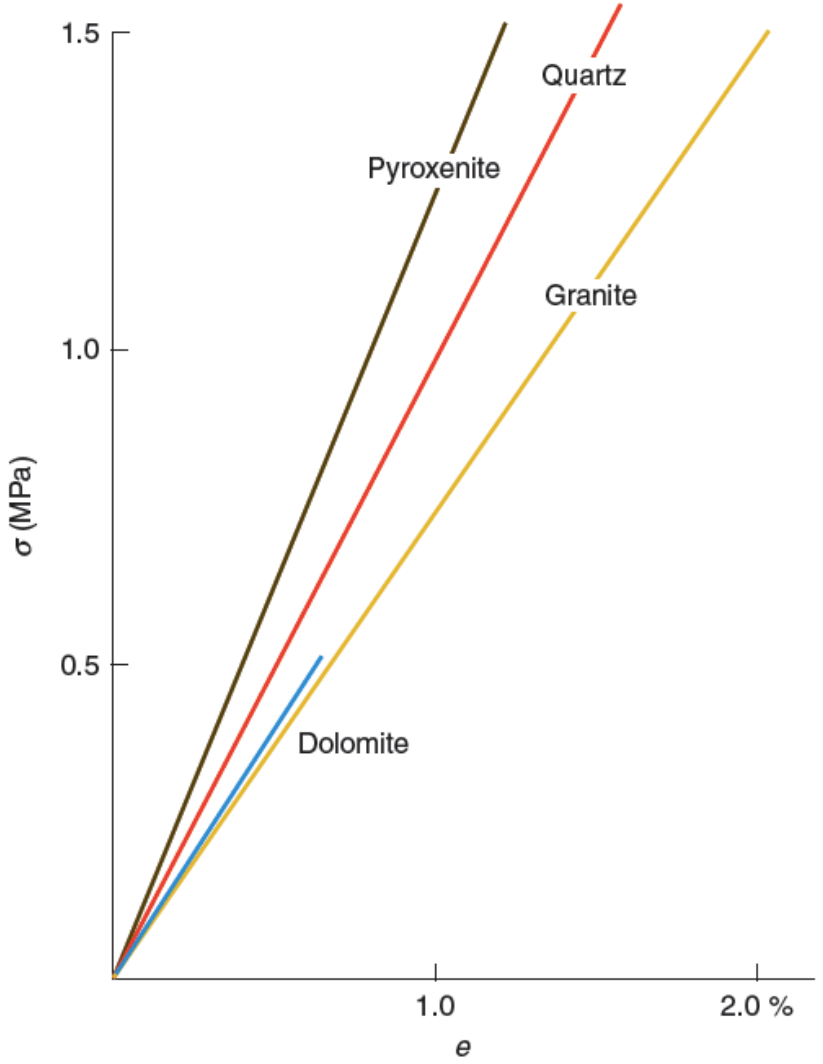



**Figure 6.4** Some minerals and rocks show linear elasticity, which means that they follow the same linear path in stress–strain space during stress build-up as during unloading. Data from Griggs and Handin (1960) and Hobbs *et al.* (1972).

# ÇEVRE BASINCI

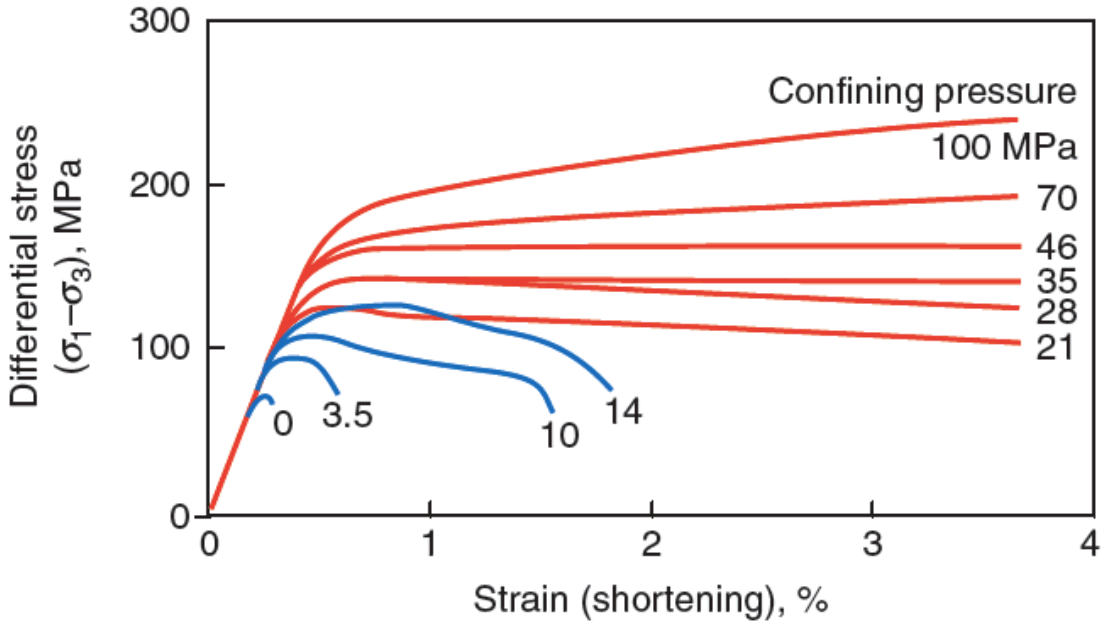



**Figure 7.8** Stress–strain curves for triaxial compression of marble for a range of confining pressures. Increasing the confining pressure increases the differential stress that the rock can sustain before failure (blue curves). Above a critical confining pressure the rock retains its strength as it deforms plastically (red curves). From Paterson (1958).

ÇEVRE BASINCI

+SICAKLIK

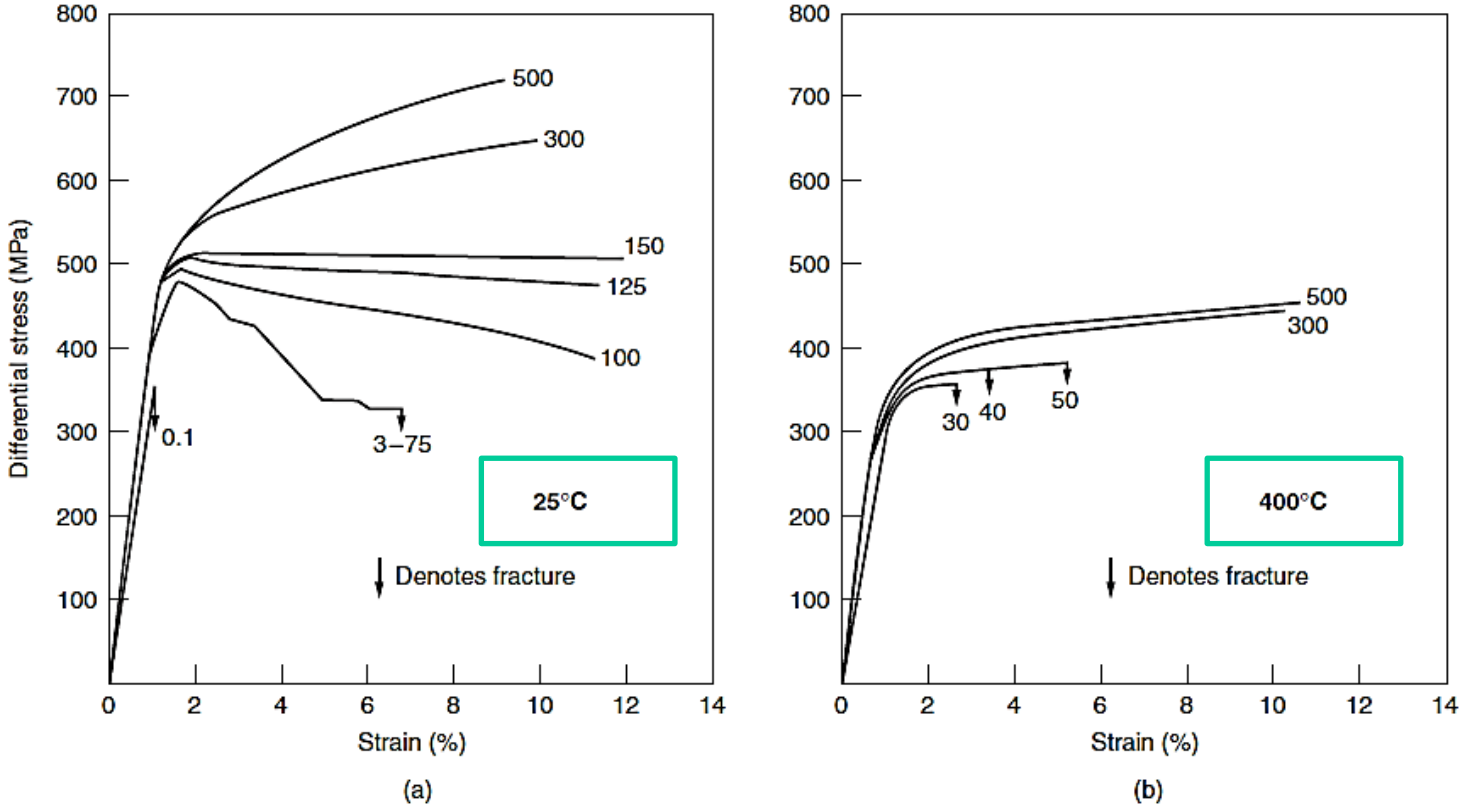



**FIGURE 5.10** Compression stress–strain curves of Solnhofen limestone at various confining pressures (indicated in MPa) at (a) 25°C and (b) 400°C.

| | ETKİ | AÇIKLAMA |
|---|---|---|
| ÇEVRE BASINCI ↑ | Kırılmayı baskılar<br>Sünümlülüğü arttırır<br>Dayanımı arttırır<br>Deformasyon direncini arttırır | Kırılmayı ve sürtünmeli kaymayı engeller,<br>Kırılma için gereken gerilme, sünümlü akma için gereken gerilme değerini aşar |

KUVVETİN UYGULANMA ŞEKLİ + SICAKLIK

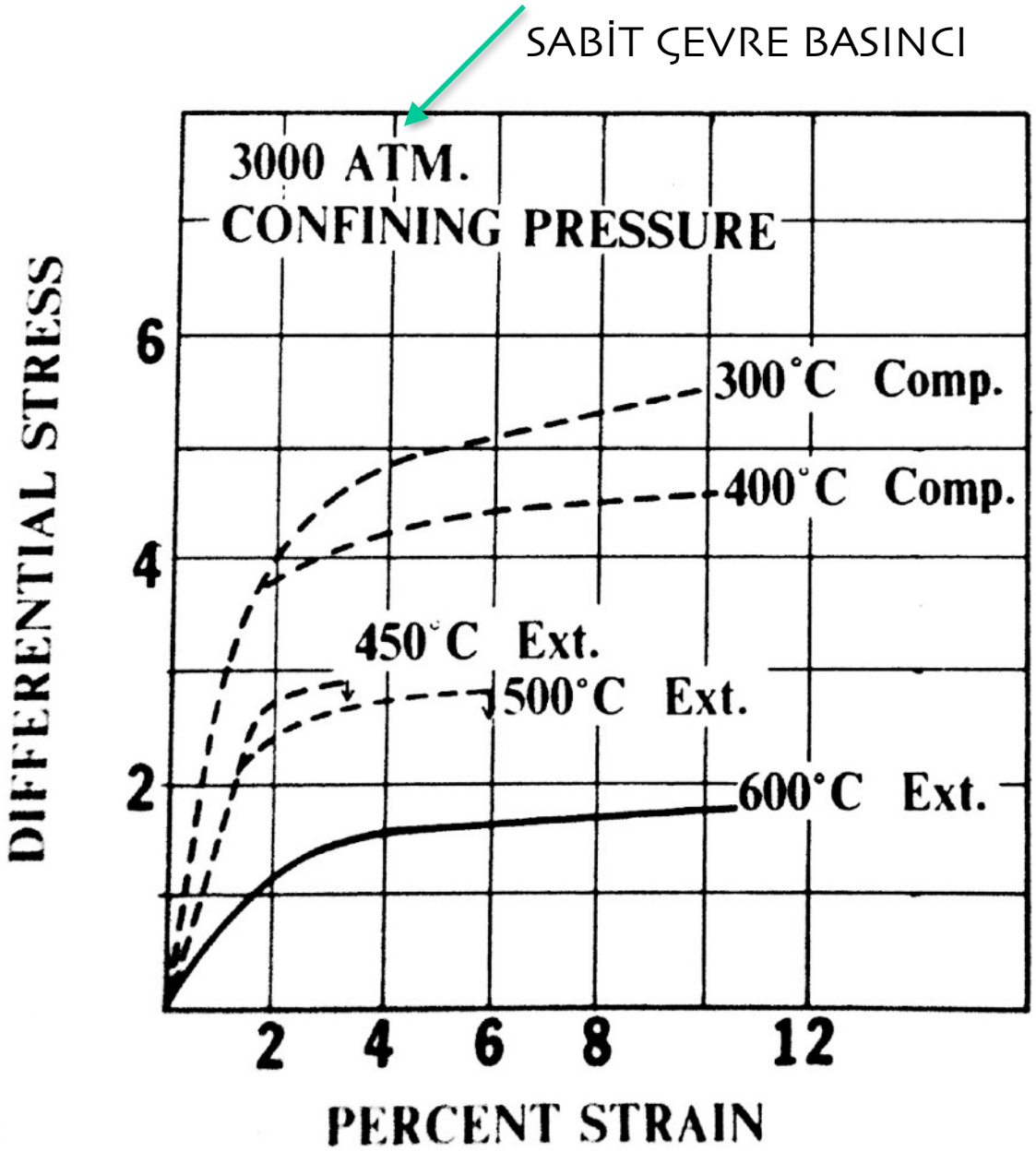
YÜKSEK SICAKLIK ↑

ETKİ

Elastik bileşeni azaltır
Kırılmayı baskılar
Sünümlülüğü arttırır
Dayanımı düşürür
Deformasyon direncini azaltır

AÇIKLAMA

Kristal plastik süreçleri destekler



# GÖZENEK SIVILARI BASINCI

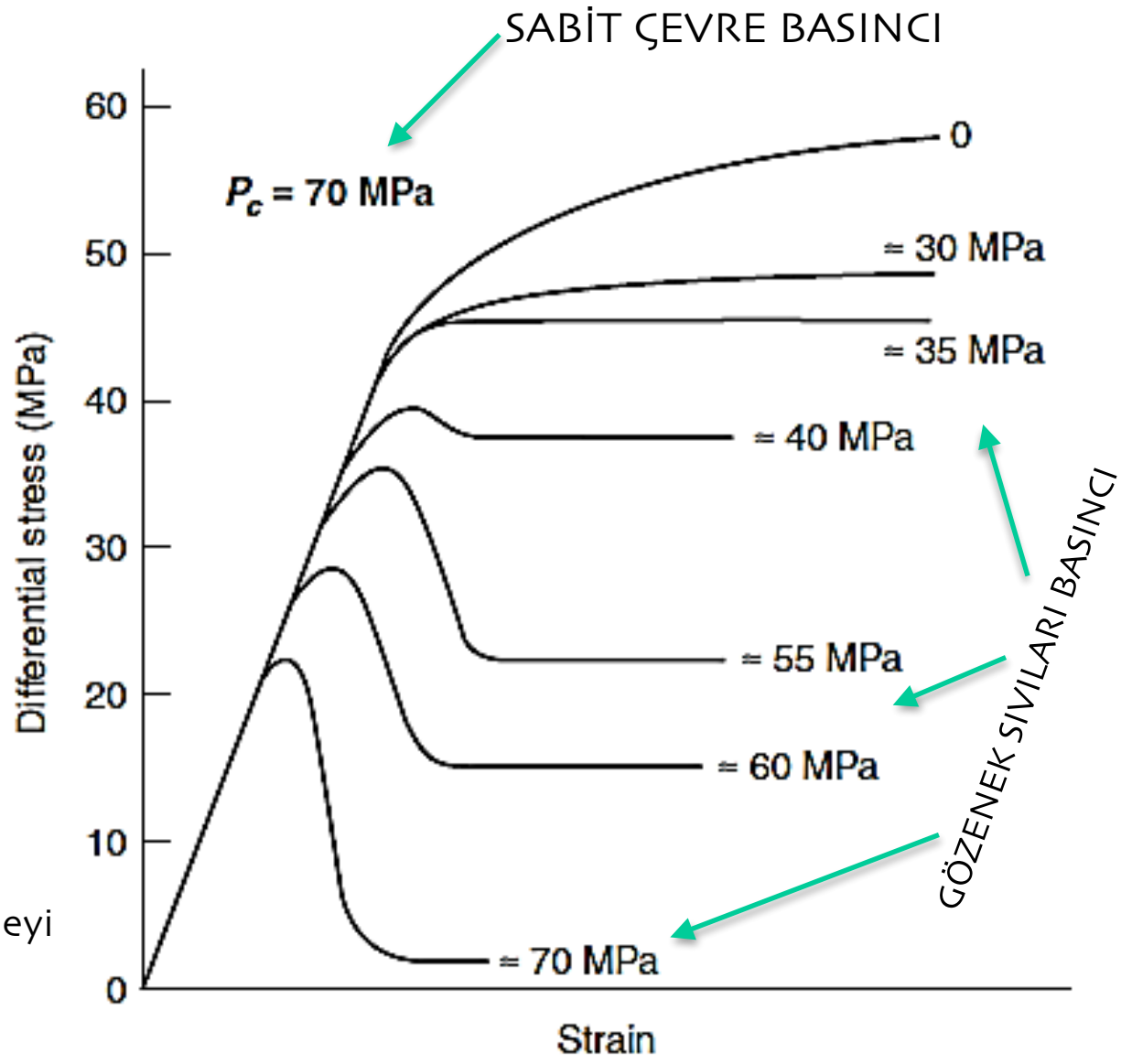
YÜKSEK GÖZENEK SIVILARI BASINCI

ETKİ

Elastik bileşeni azaltır
Kırılganlığı teşvik eder
Sünümlülüğü azaltır
Dayanımı düşürür veya akmayı teşvik eder

AÇIKLAMA

Çevre basıncını azaltır, Si-O arasındaki atomik bağları zayıflatır, yani sürtünmeyi azaltır



# SÜREKSİZLİKLERİN KONUMU

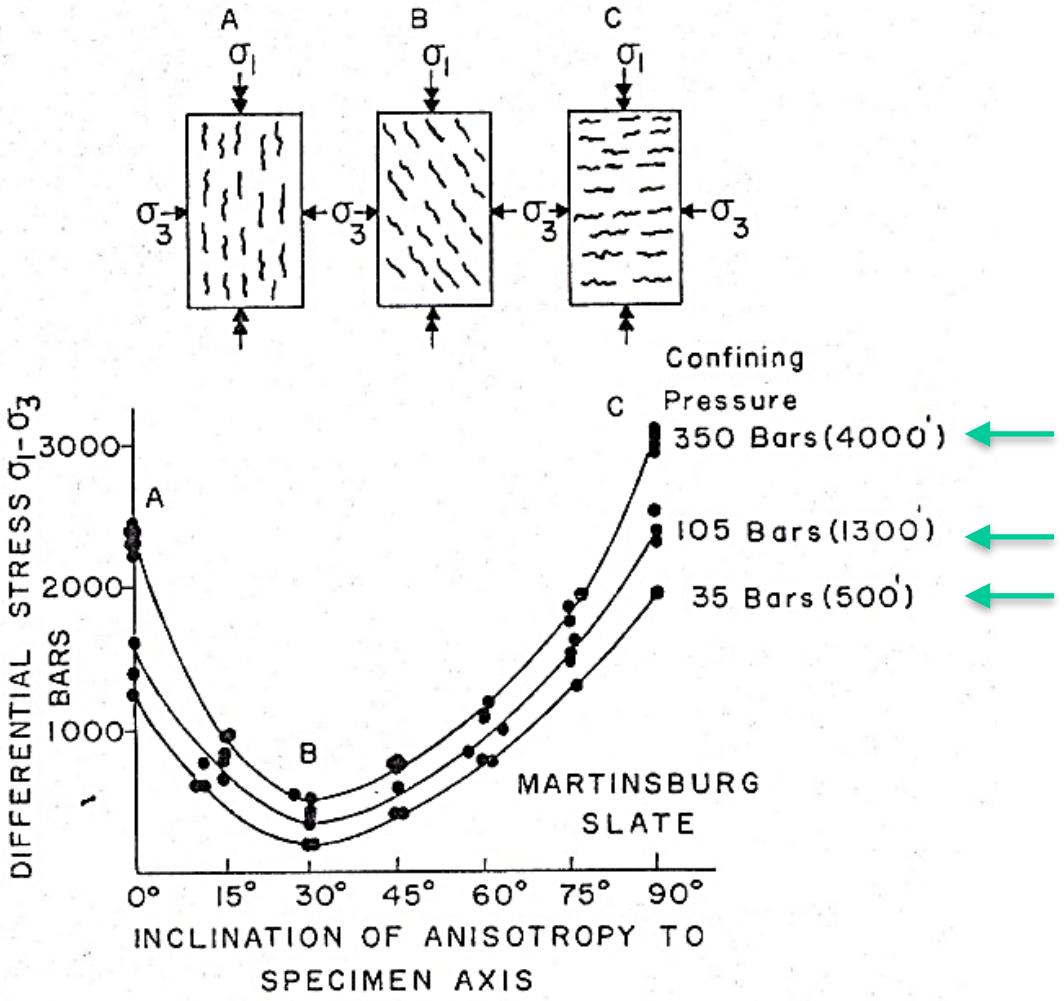



**Fig. 2–52.** Breaking strength vs. inclination of cleavage, Martinsburg slate, at room temperatures. Note that the strength is greatest when cleavage is oriented at 90° to the core axis. The orientation of foliation relative to stress application is shown in the block diagrams above the graphs. (From F. A. Donath [1961], *Bull. Geol. Soc. Am.*, **72**.)

# DEFORMASYON HIZI (ORANI)

DÜŞÜK
DEFORMASYON HIZI

ETKİ

Elastik bileşeni azaltır
Sünümlülüğü arttırır
Dayanımı düşürür
Deformasyon direncini azaltır

AÇIKLAMA

Kristal plastik süreçleri destekler

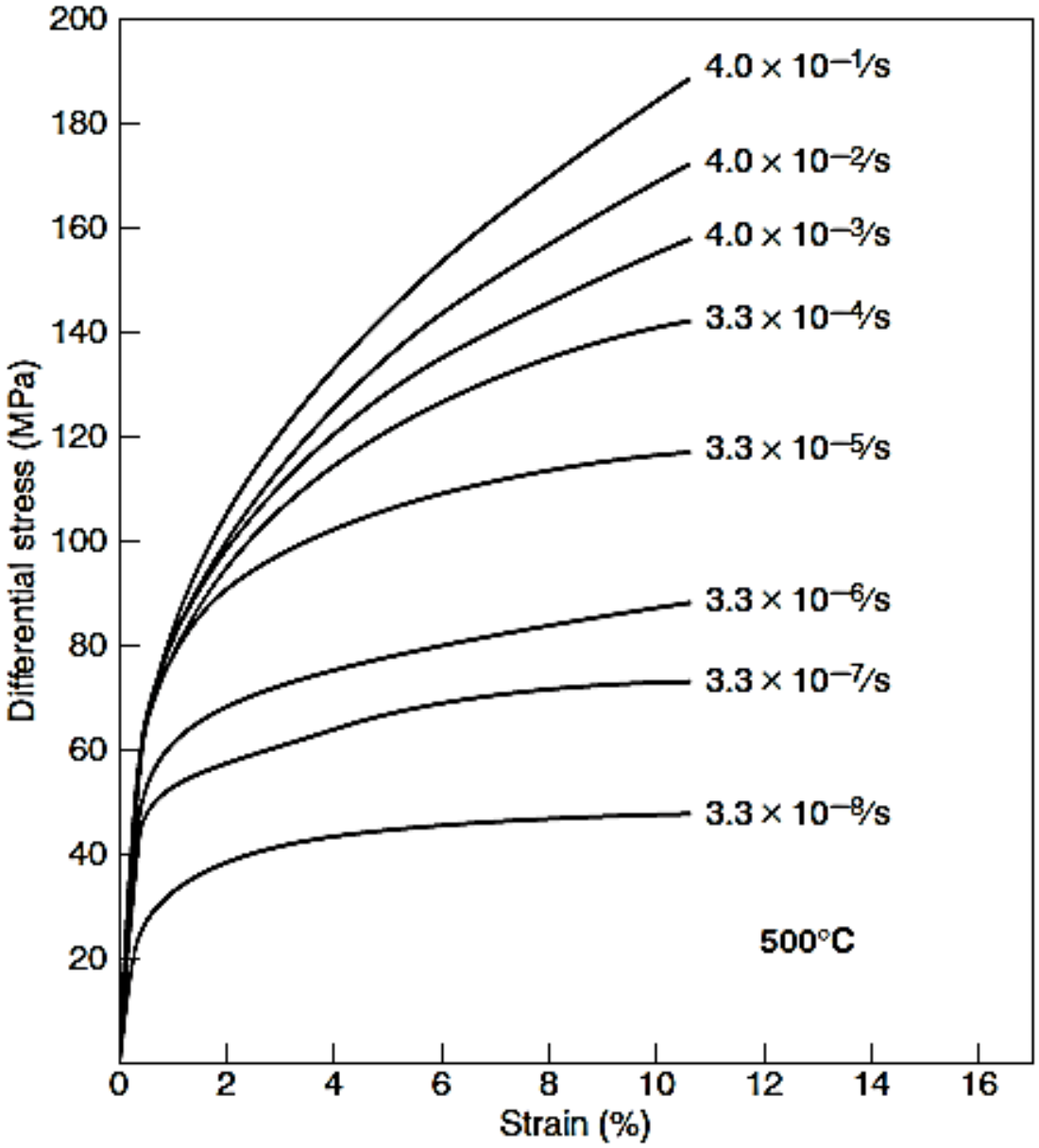
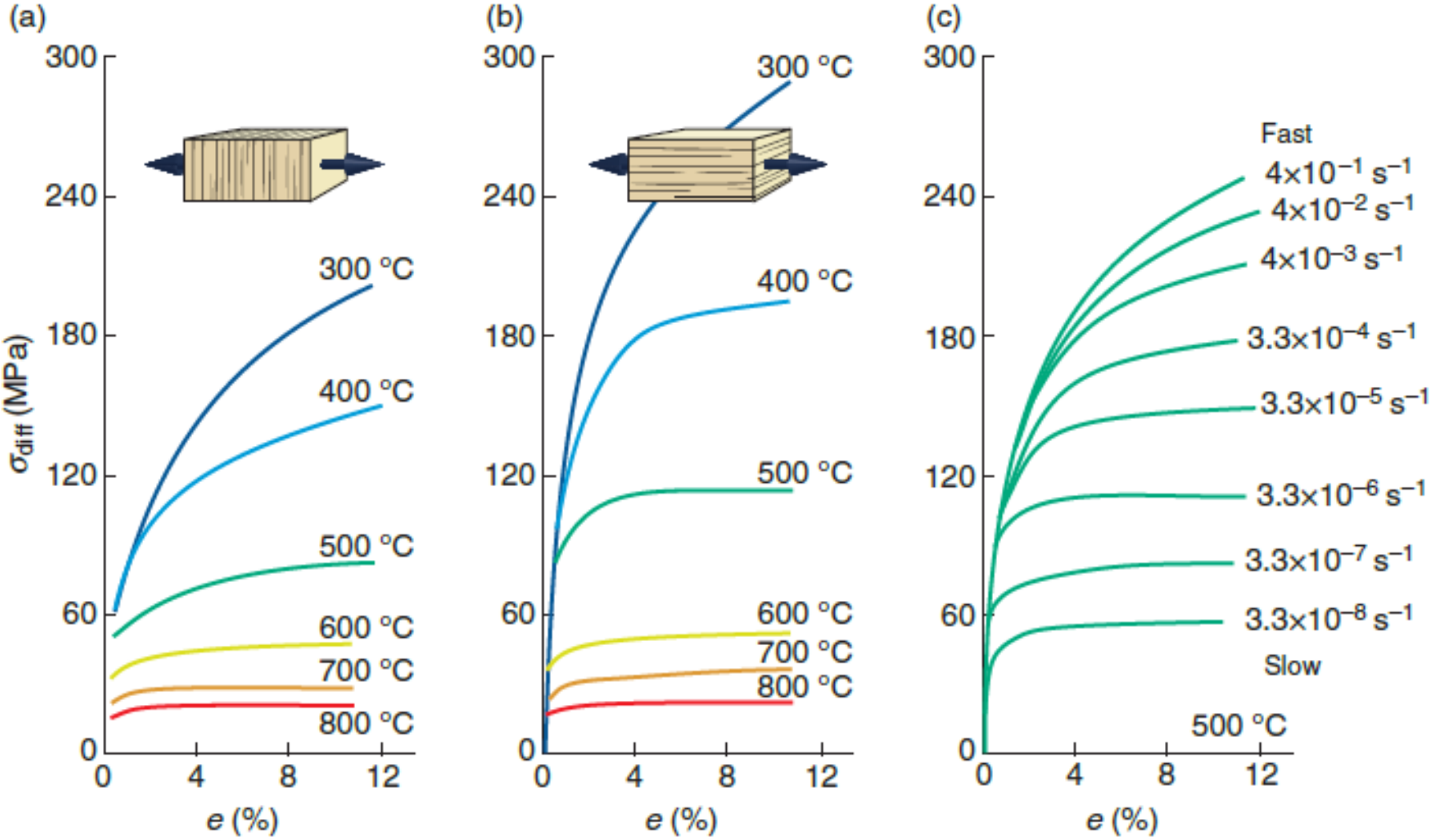



**FIGURE 5.14** Stress versus strain curves for extension experiments in weakly foliated Yule marble for various constant strain rates at 500°C.

# DEFORMASYON HIZI (ORANI)




| | ETKİ | AÇIKLAMA |
|---|---|---|
| DÜŞÜK DEFORMASYON HIZI | Elastik bileşeni azaltır<br>Sünümlülüğü arttırır<br>Dayanımı düşürür<br>Deformasyon direncini azaltır | Kristal plastik süreçleri destekler |

**Increasing the temperature, increasing the amount of fluid, lowering the strain rate and, in plastically deforming rocks, reducing the grain size all tend to cause strain weakening.**

Plastic strain is the permanent change in shape or size of a body without fracture, accumulated over time by a sustained stress beyond the elastic limit (yield point) of the material.

KATAKLASTİK DEFORMASYON

Düşük çevre basıncı
Yüksek gözenek sıvıları basıncı
Düşük sıcaklık
Yüksek deformasyon oranı
Yüksek gerilme

TANELER ARASI KAYMA

Yüksek çevre basıncı
Düşük gözenek sıvıları basıncı
Yüksek sıcaklık
Düşük deformasyon oranı
Düşük gerilme miktarı

REKRİSTALİZASYON

Kimyasal aktif akışkan
Yüksek sıcaklık
Düşük deformasyon oranı
Düşük gerilme miktarı