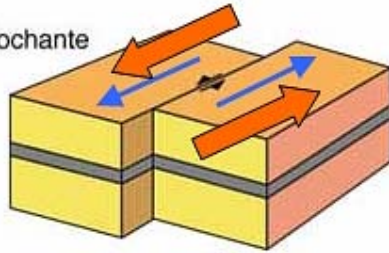


# QUANTIFICATION DES AMPLITUDES ET DES TAUX DE DEFORMATION

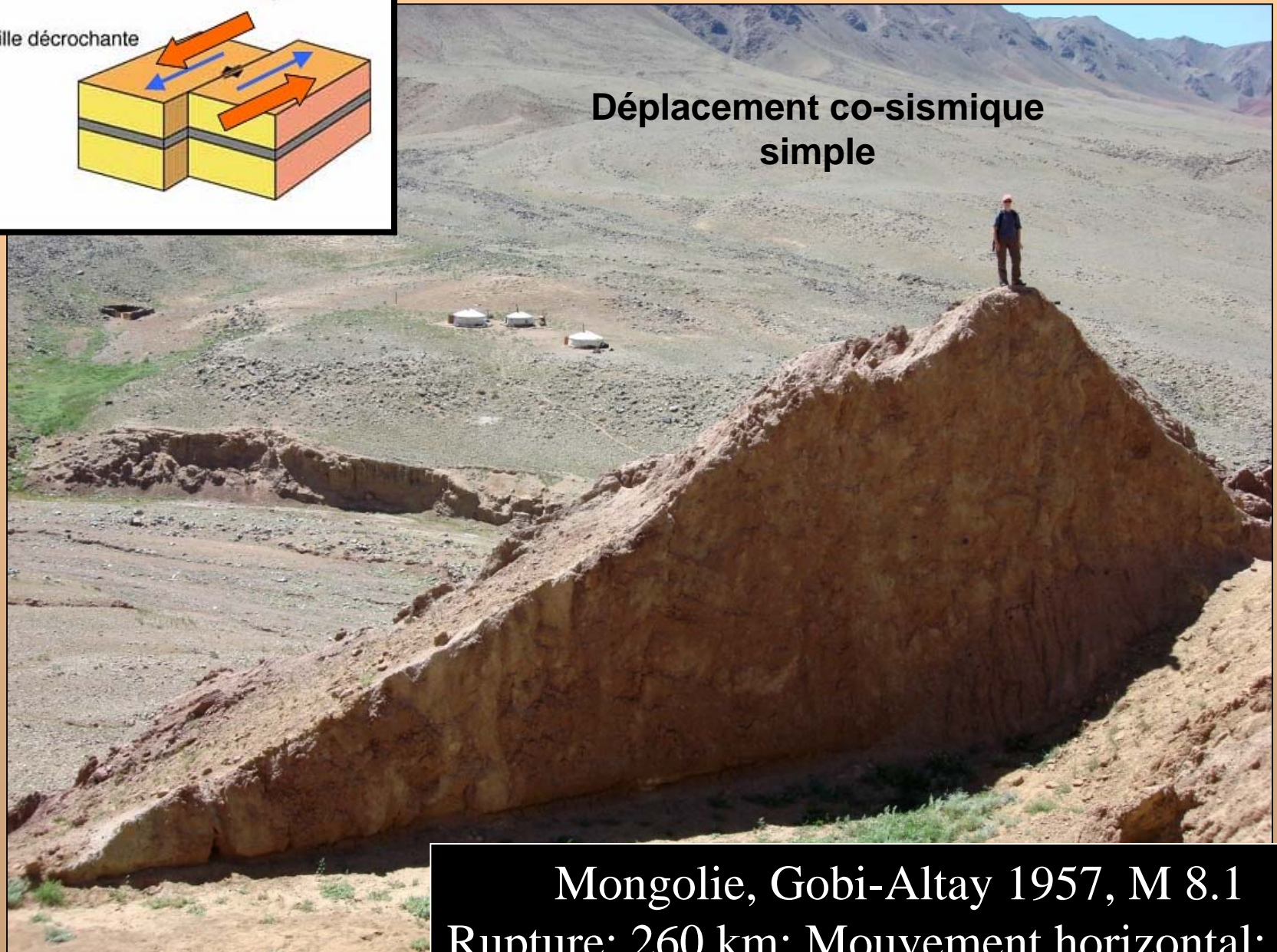


# CONTEXTE DECROCHANT

Faille décrochante

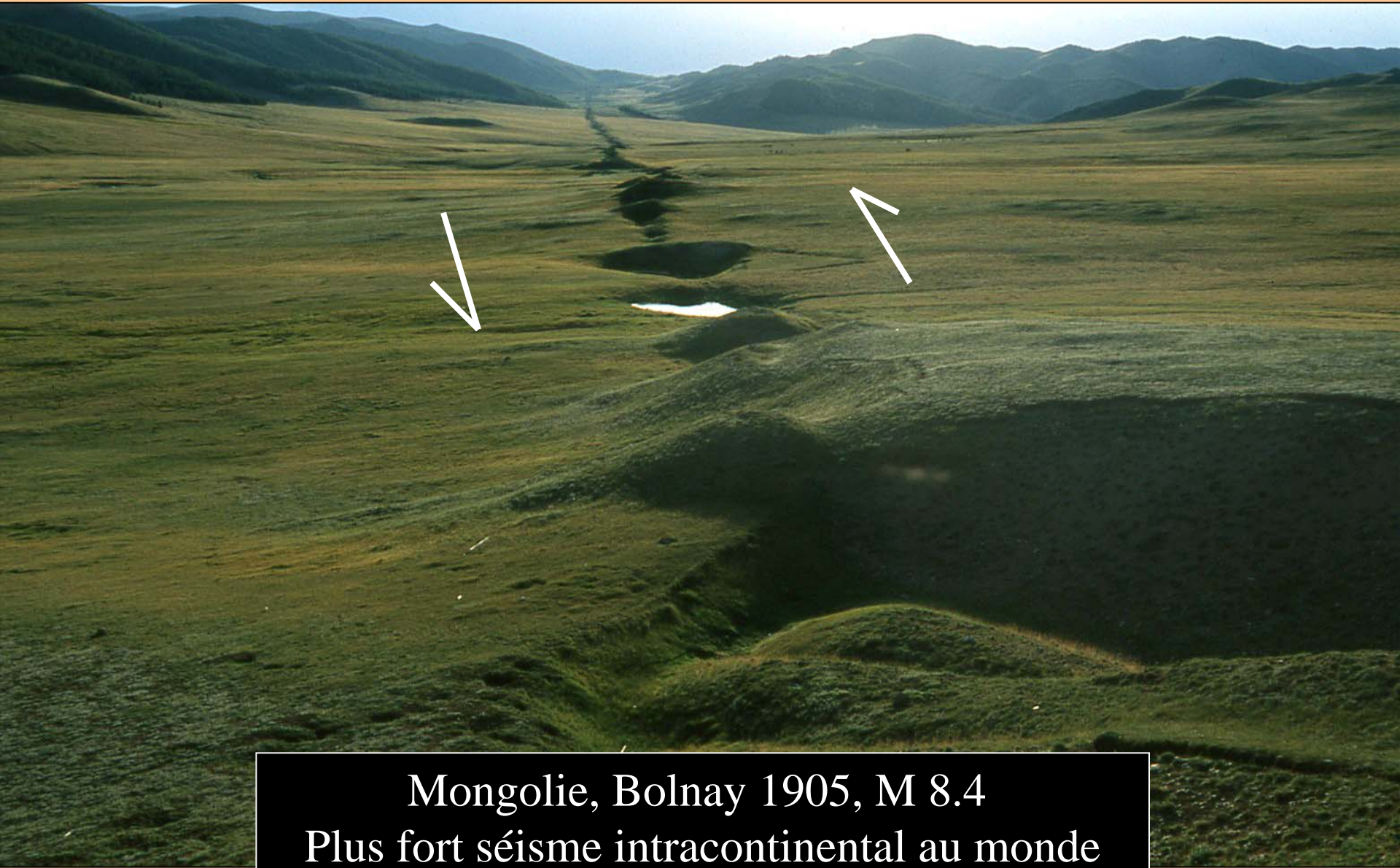


Déplacement co-sismique simple



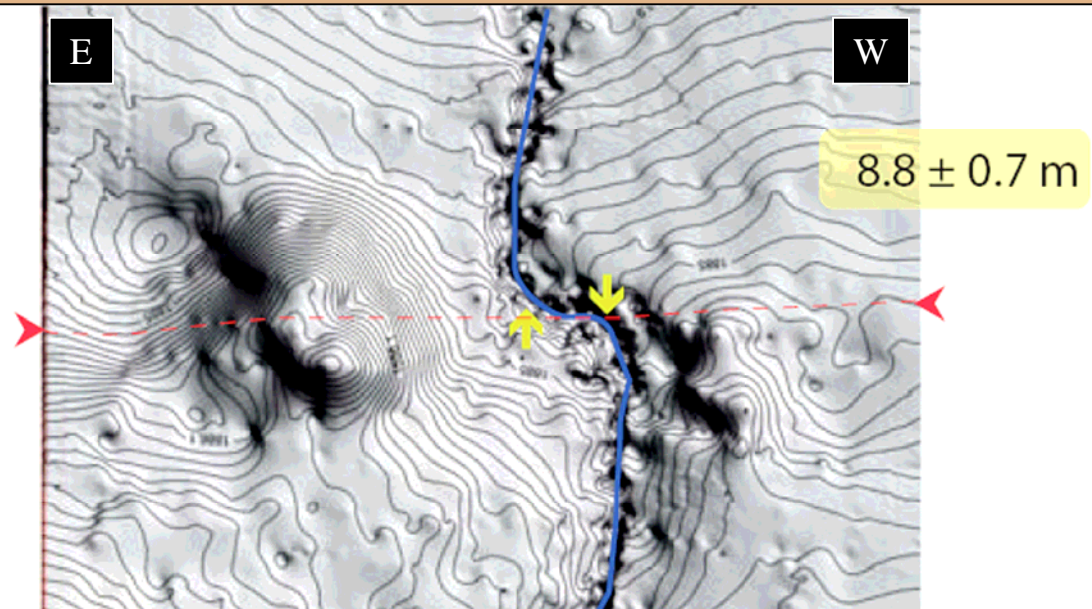
Mongolie, Gobi-Altay 1957, M 8.1  
Rupture: 260 km; Mouvement horizontal: 5 m

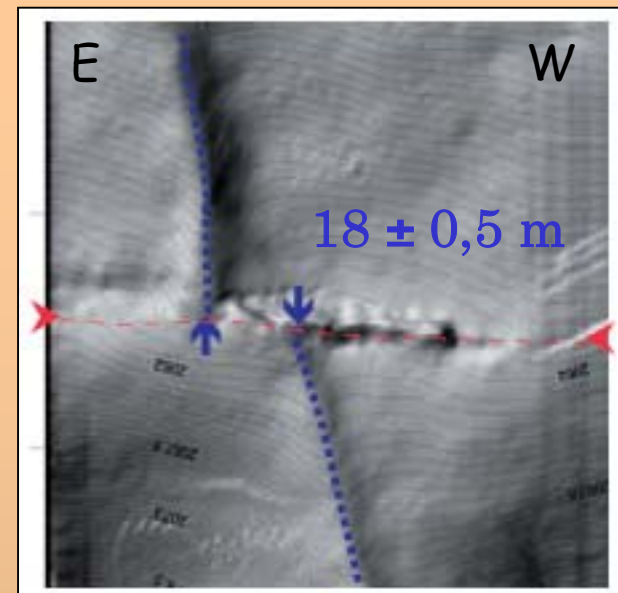
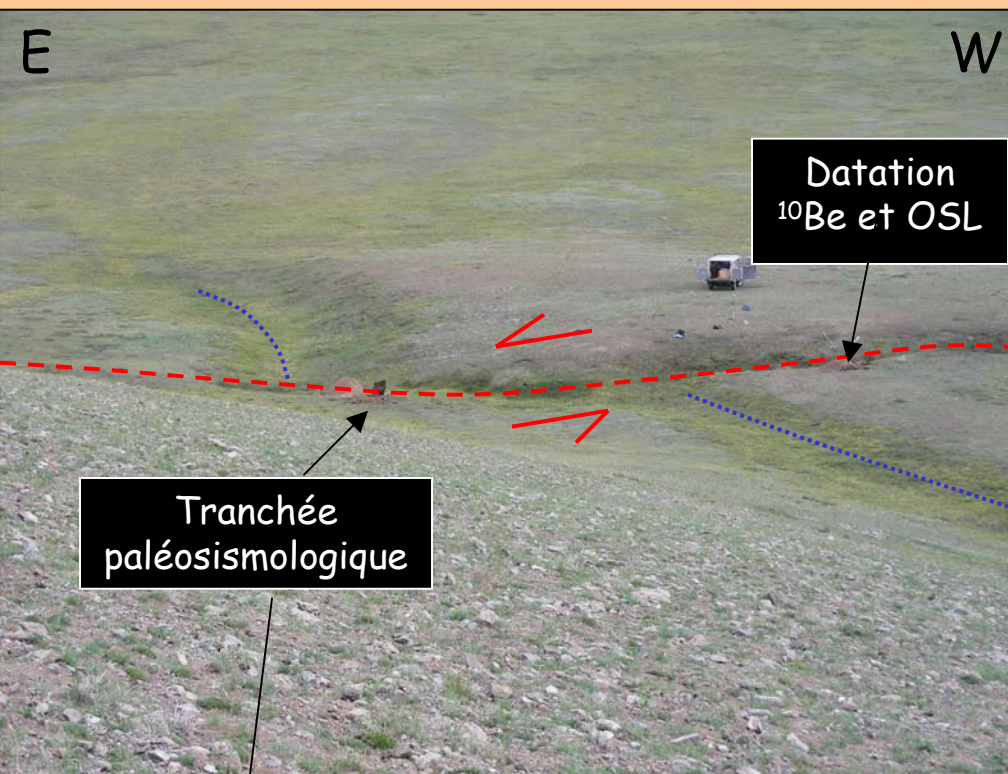
## Déplacement co-sismique simple et cumulé



Mongolie, Bolnay 1905, M 8.4  
Plus fort séisme intracontinental au monde  
Rupture: 400 km; Mouvement horizontal: 9 m

Détermination du déplacement co-sismique de 1905 par analyse du décalage des rivières





Déplacement cumulé: 2 séismes

Mesure du décalage de l'incision affectant le cône alluvial ( $18 \pm 0,5 \text{ m}$ ) divisée par l'âge d'exposition du cône ( $5,2 \pm 0,3 \text{ ka}$ ):

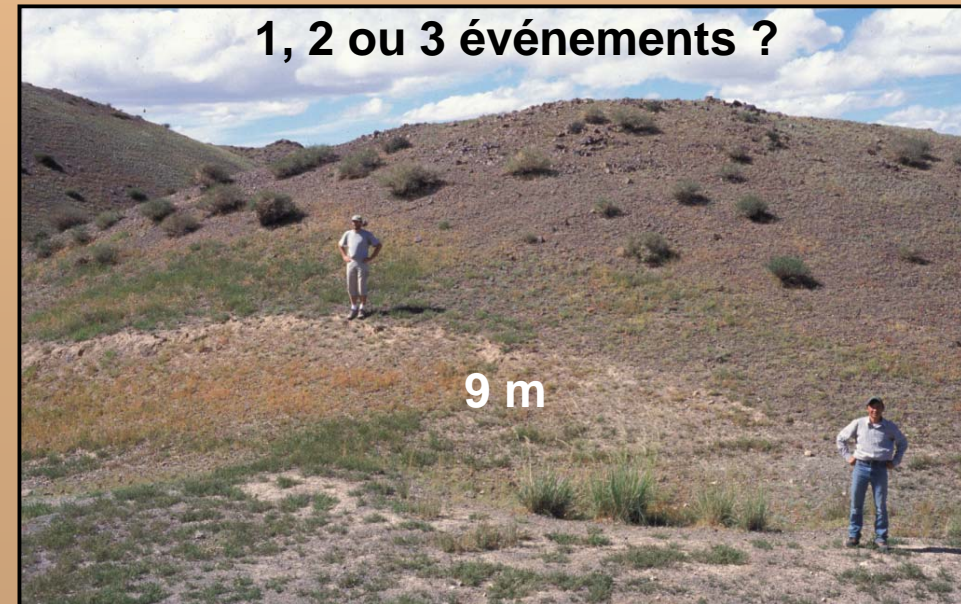
Vitesse holocène de la faille:  $3,5 \pm 0,3 \text{ mm/an}$



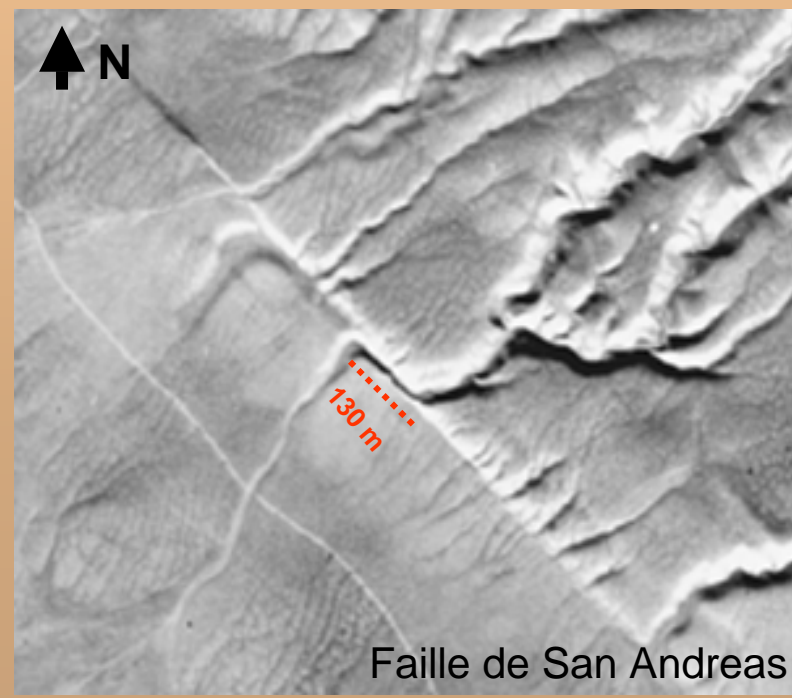
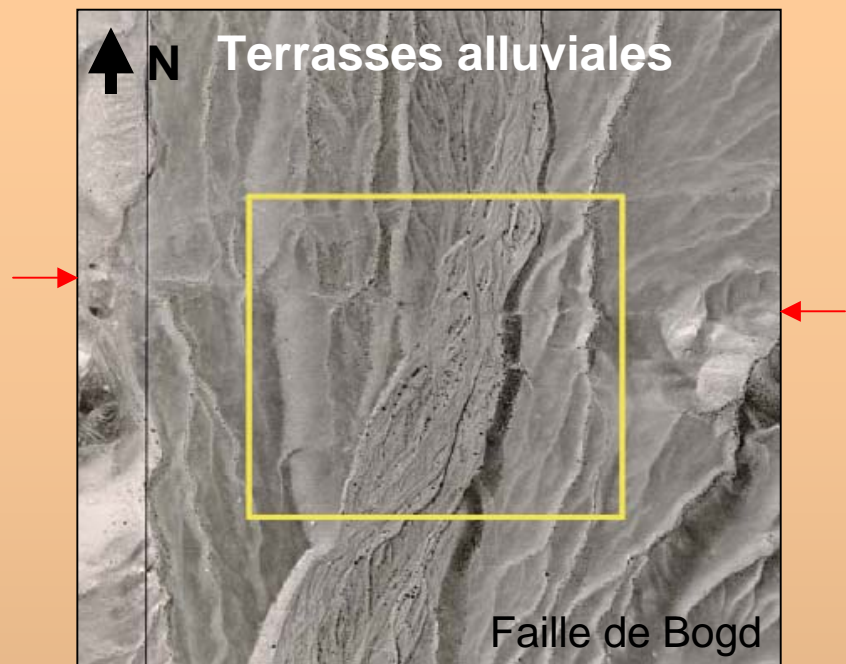
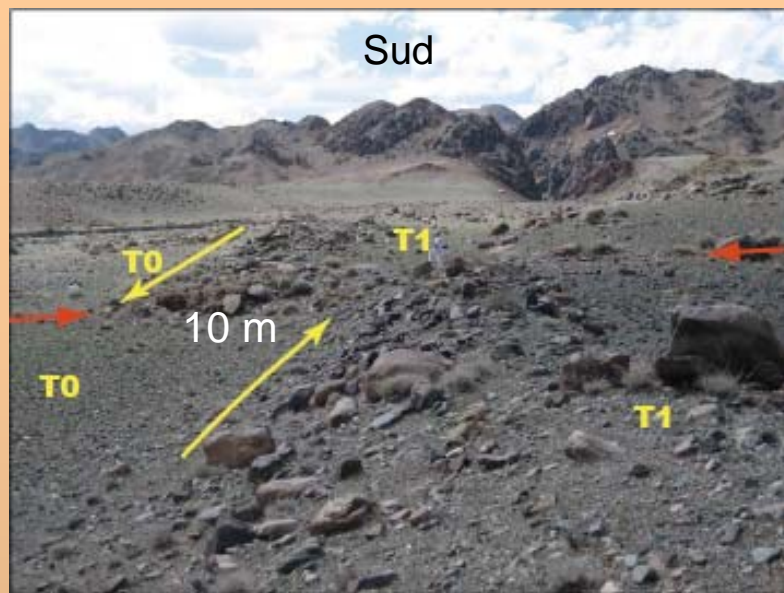
Analyse des ruptures et datation d'horizons sismo-sédimentaires dans des tranchées paléosismologiques:  
Récurrence des séismes: 2000-3000 ans

**Décalage horizontal  
de rides, barres,  
talwegs, rivières...**

Faïlle de Bogd, Mongolie



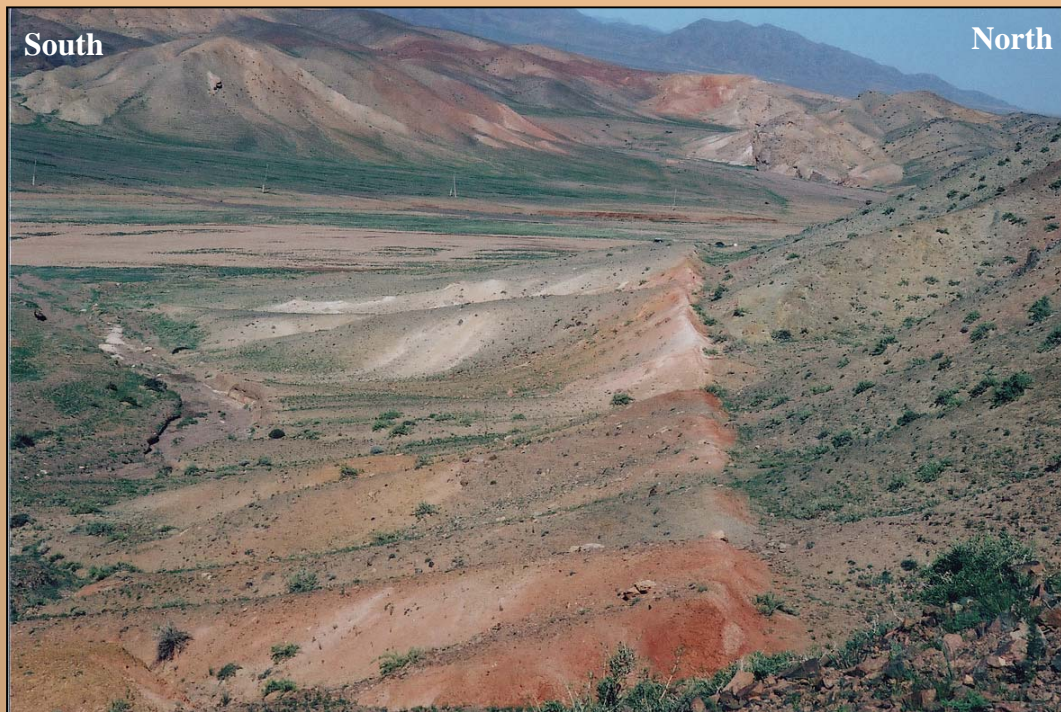
# Déplacement cumulé (plusieurs séismes)

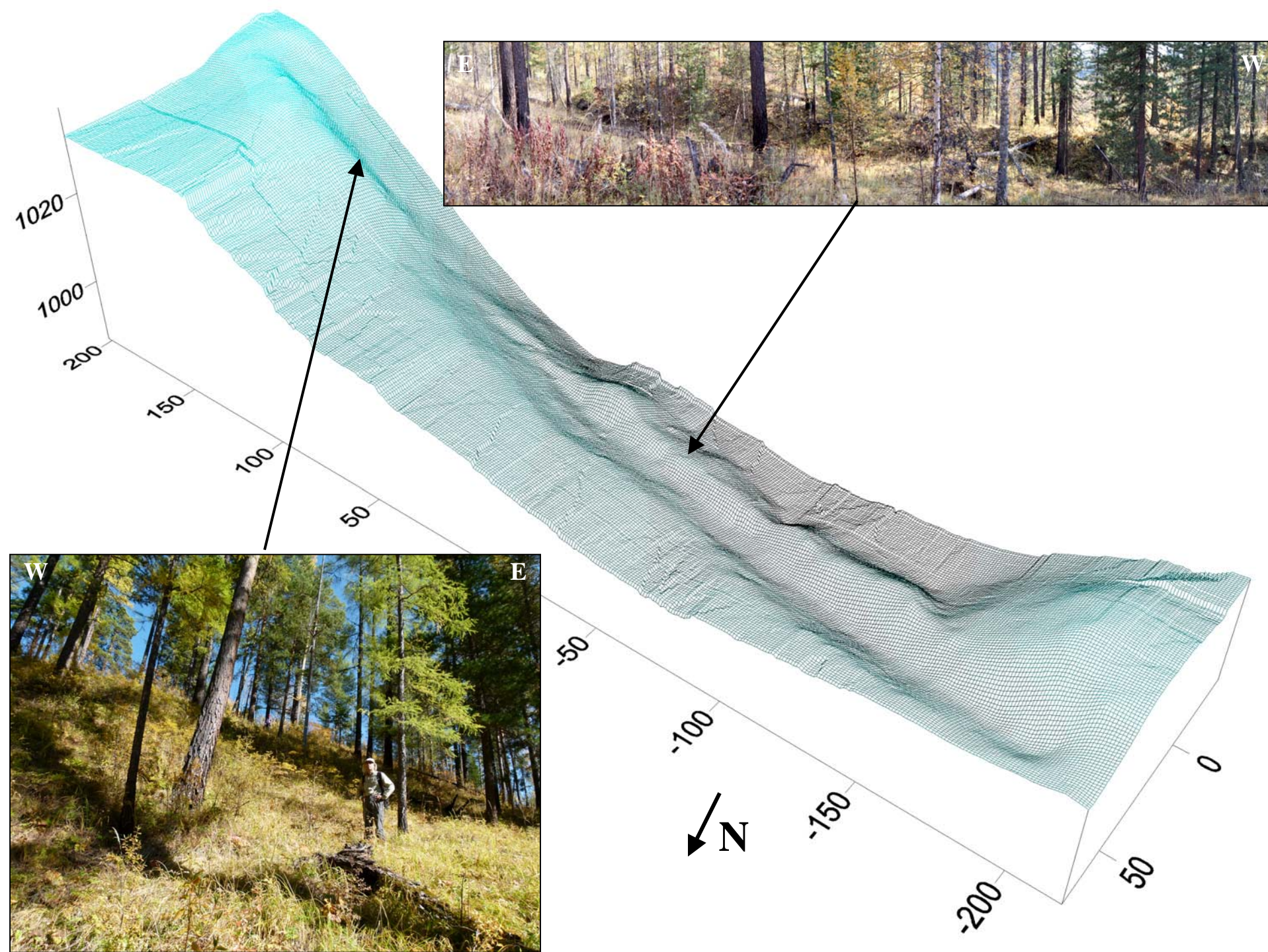


# Contre-escarpements sur un versant : mouvement vertical apparent









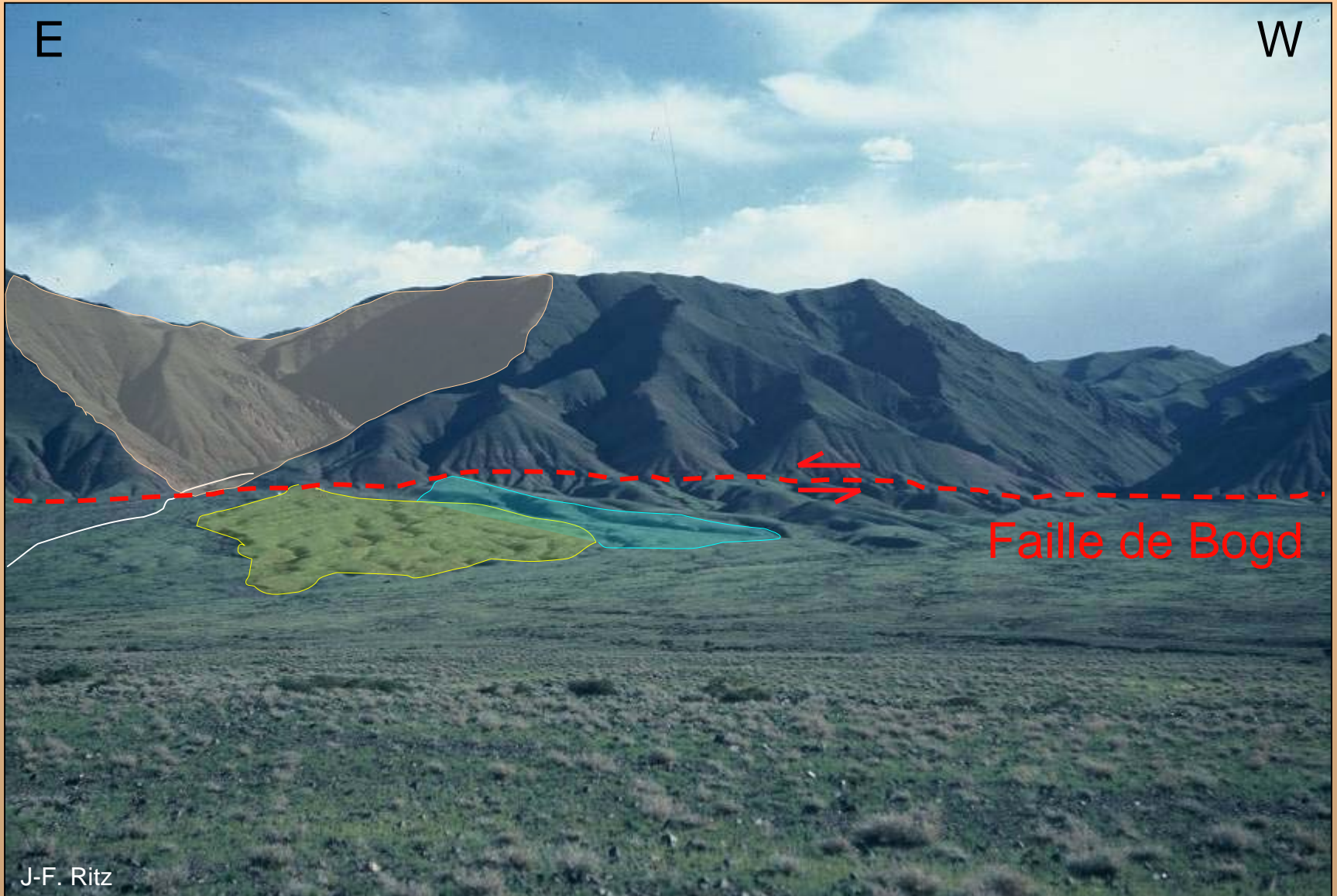
# Décalage d'apex de cônes alluviaux par rapport à leur exutoire d'origine



J-F. Ritz

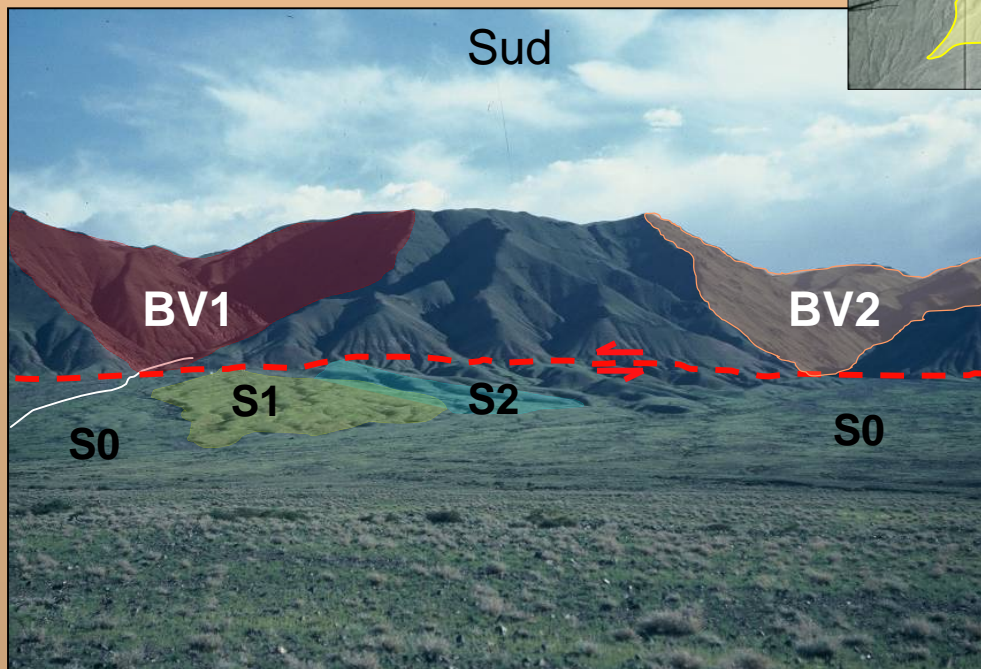
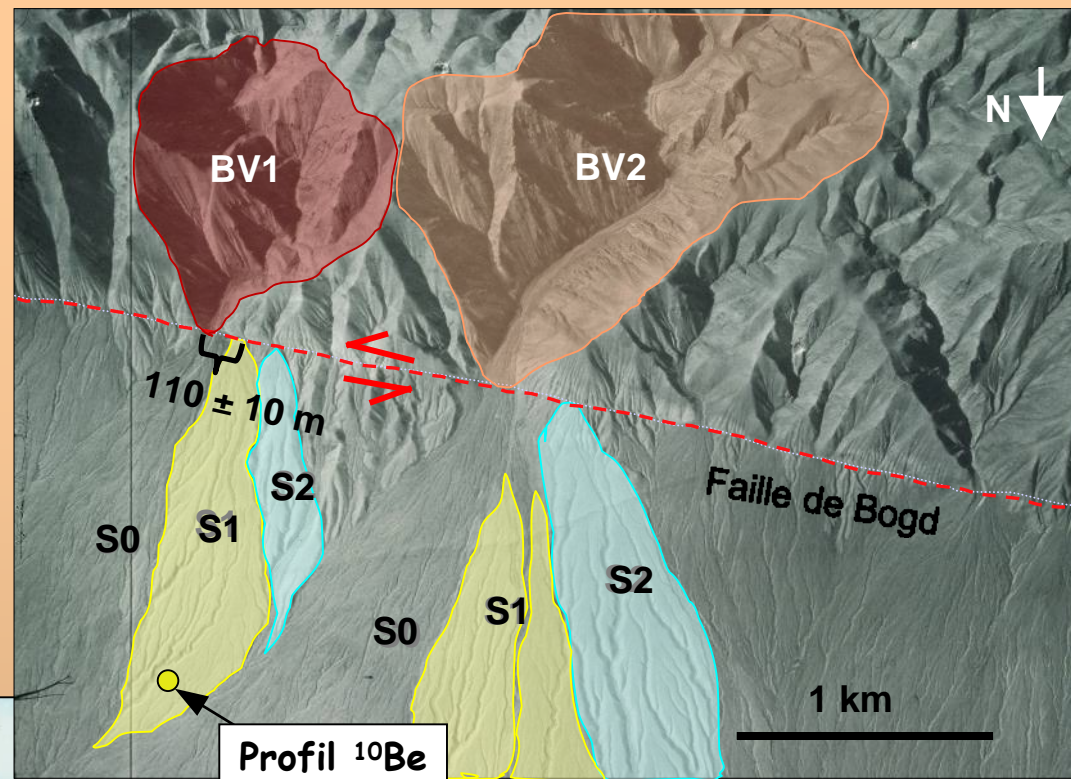
Gobi-Altay, Mongolie

# Décalage d'apex de cônes alluviaux par rapport à leur exutoire d'origine

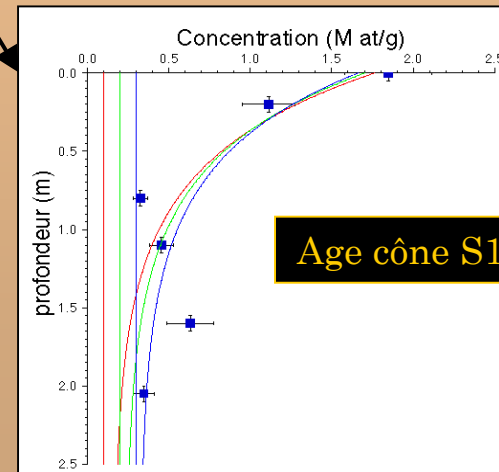


Gobi-Altay, Mongolie

# Vitesse de déplacement de la faille au Pléistocène supérieur - Holocène



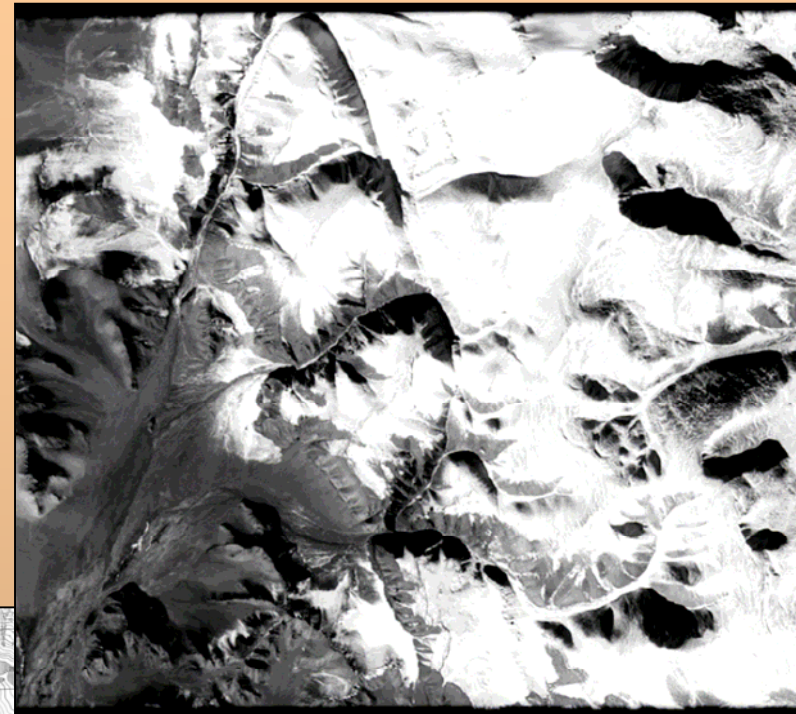
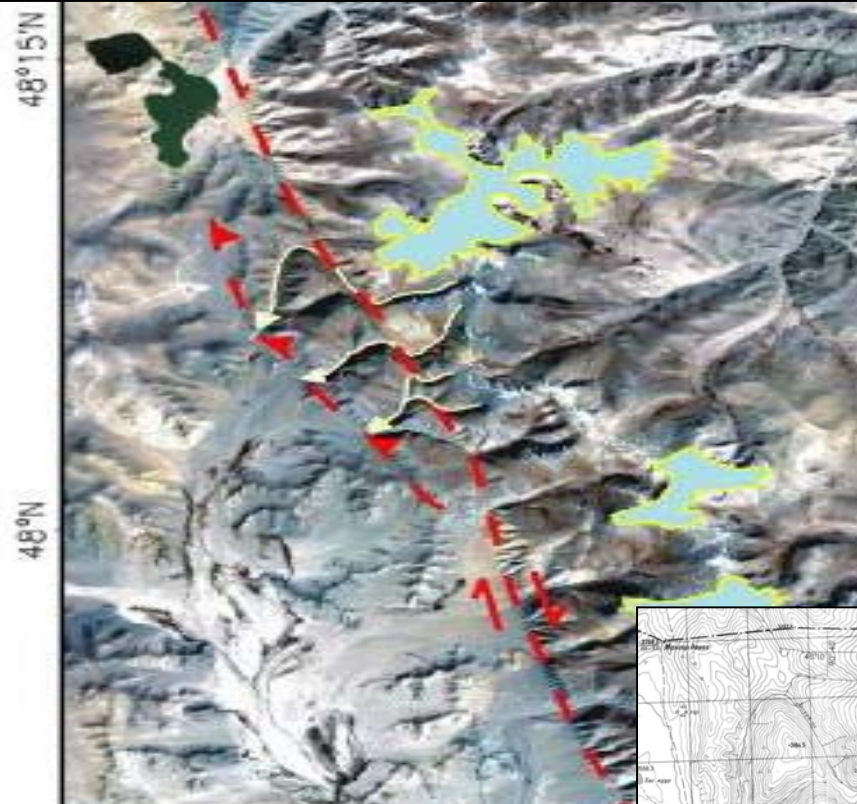
Profil  $^{10}\text{Be}$



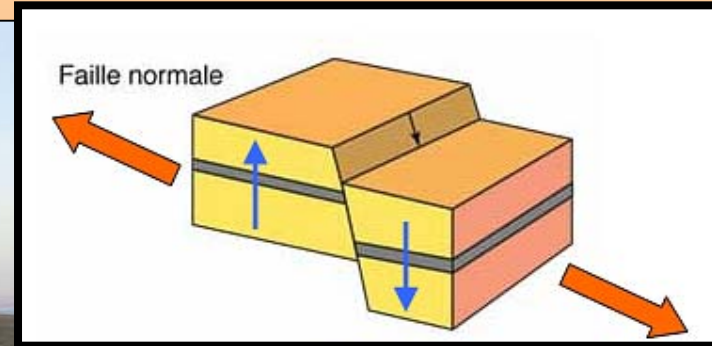
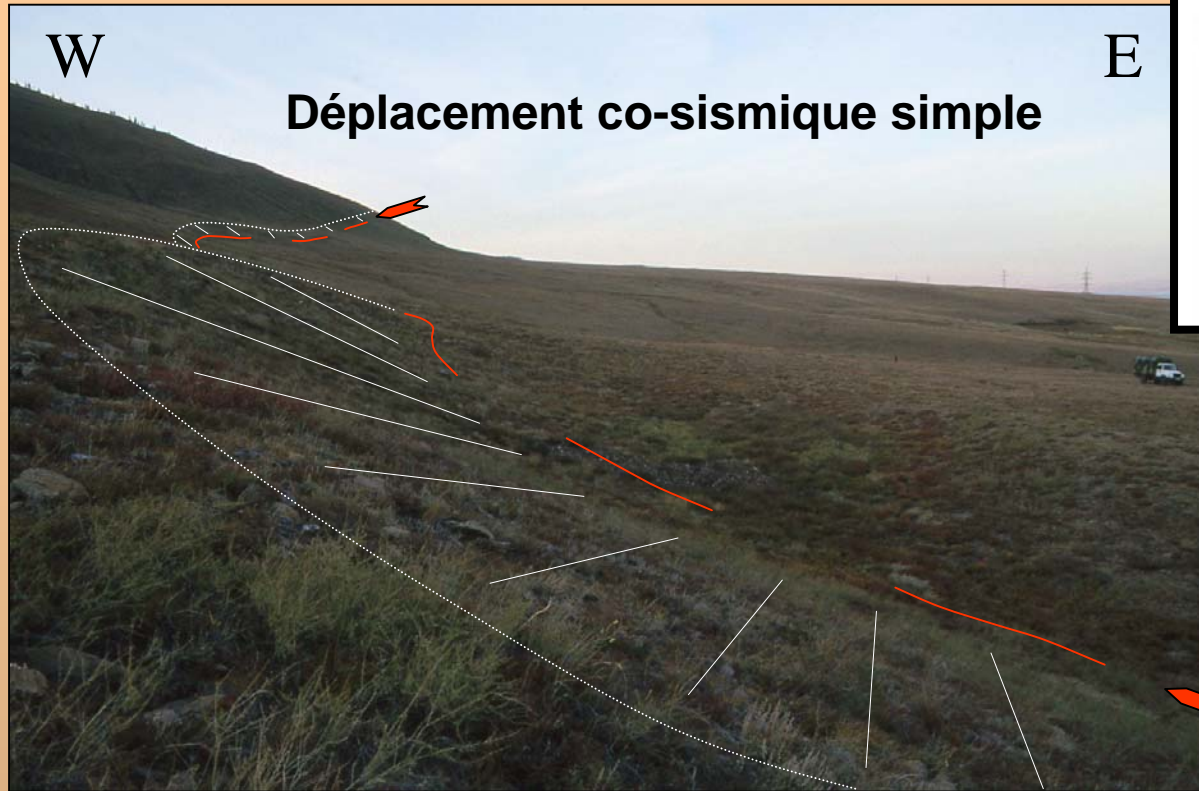
Age cône S1:  $125 \pm 28$  ka

Vitesse horizontale sur 125 ka :  $\sim 1$  mm/an

# Activité long terme: Vallées décalées



# CONTEXTE EXTENSIF



Sibérie, Transbaïkal,  
il y a quelques siècles...  
Mouvement vertical: 2-3 m

# Déplacement co-sismique cumulé pléisto-holocène



Faille de Tunka, Sibérie



N

Socle carbonaté « intact »

S

50-60°

Brèche tectonique

W

E

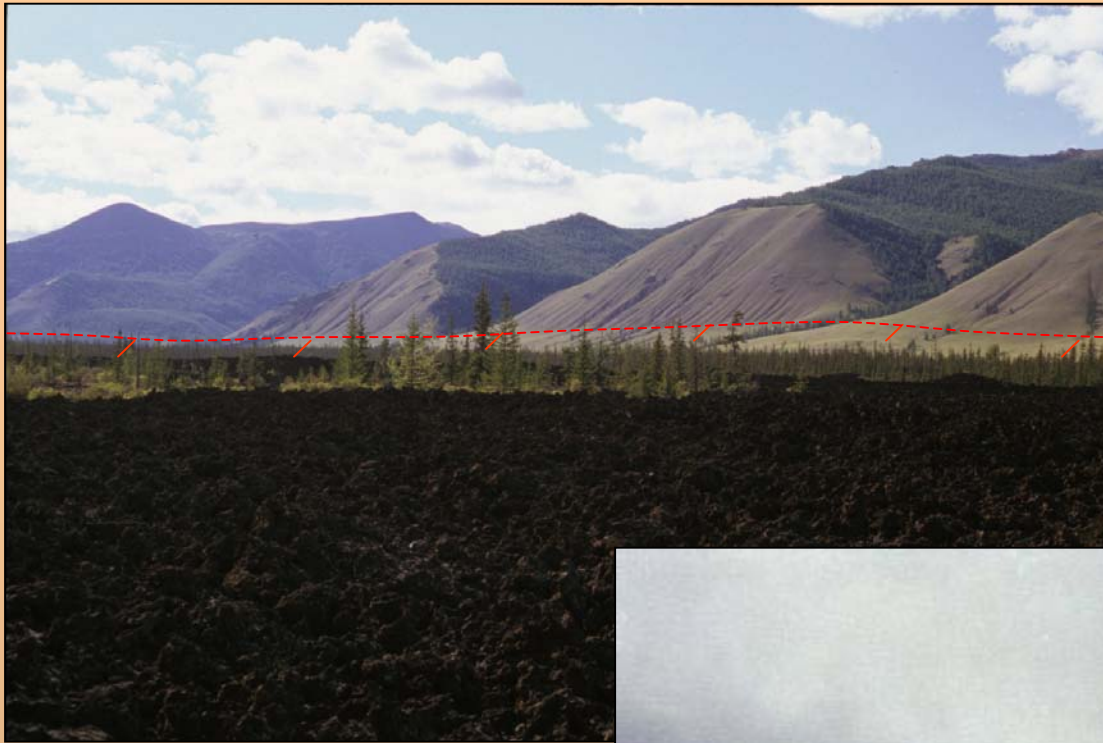
Escarpement de 15 m  
sur la surface de la  
terrasse étagée

N

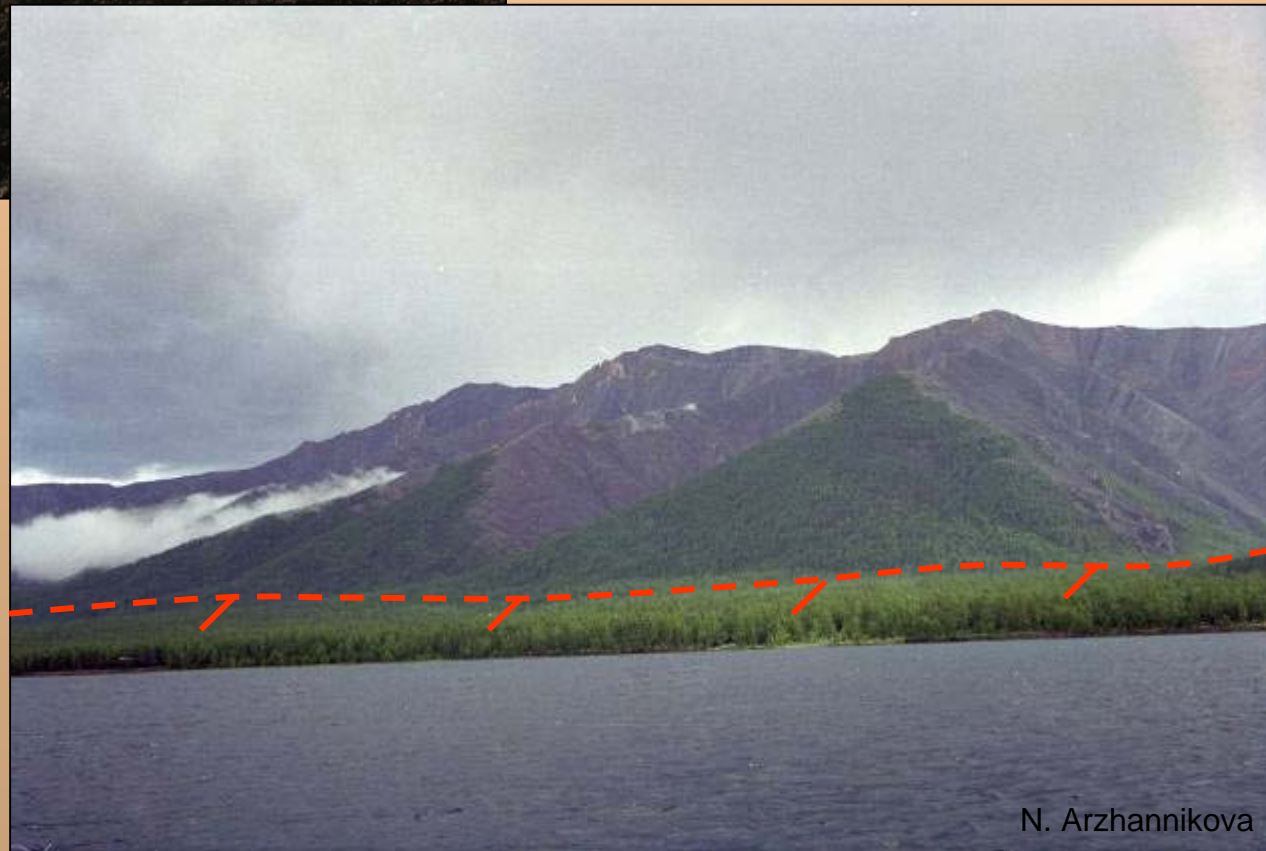
S

## Déplacement cumulé cénozoïque: facettes triangulaires

Chaîne de Sayan, Sibérie



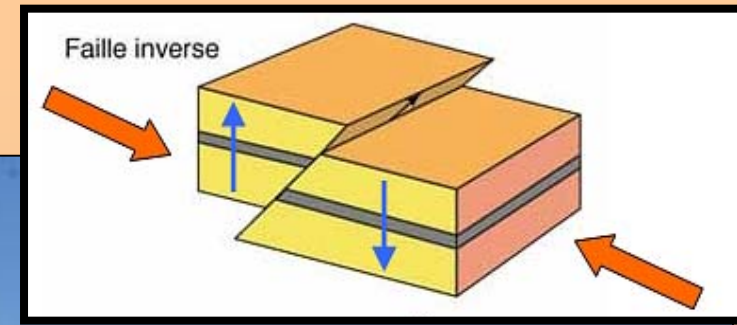
Rift du Lac Hovsgol,  
Mongolie



N. Arzhannikova

# CONTEXTE COMPRESSIF

Déplacement co-sismique  
simple



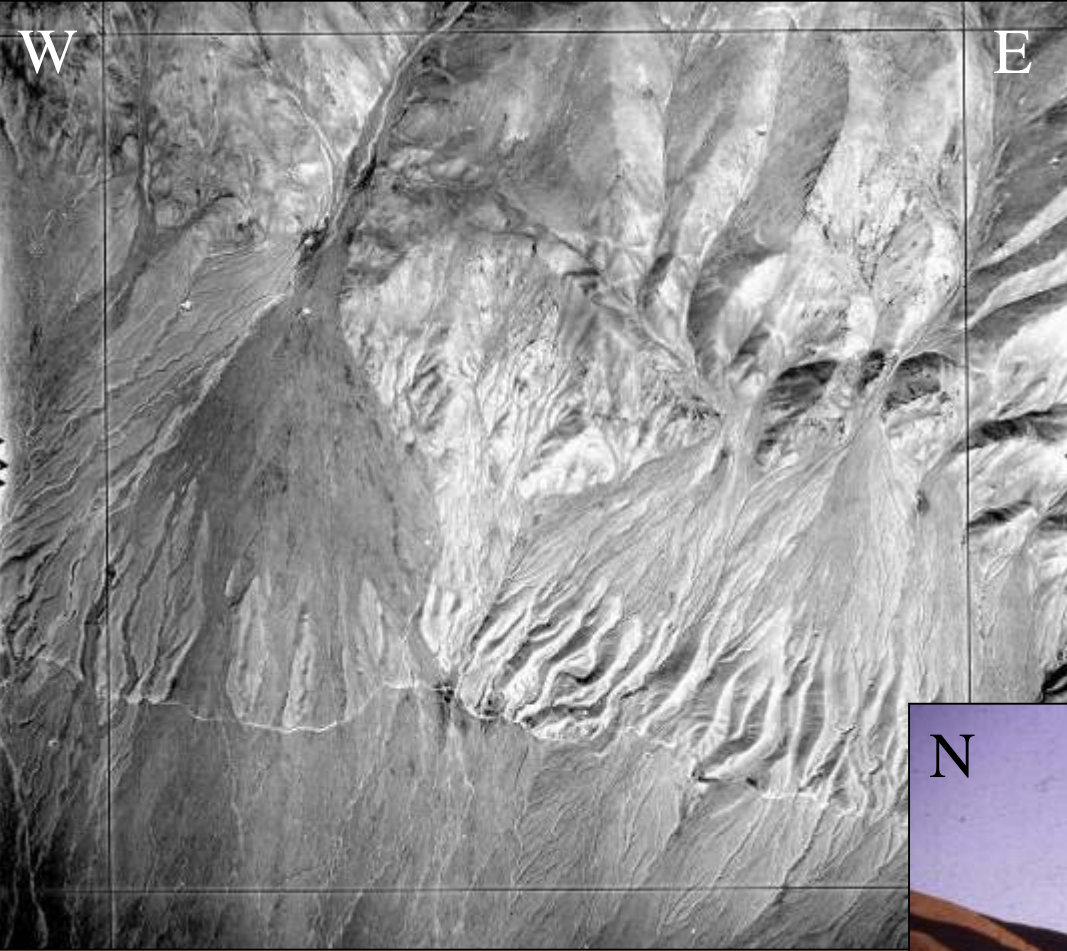
Mongolie, Gobi-Altay 1957, M 8.1  
Mouvement vertical: 4 m



**Failles inverses:  
déplacement co-sismique  
simple**

Spitak, Arménie



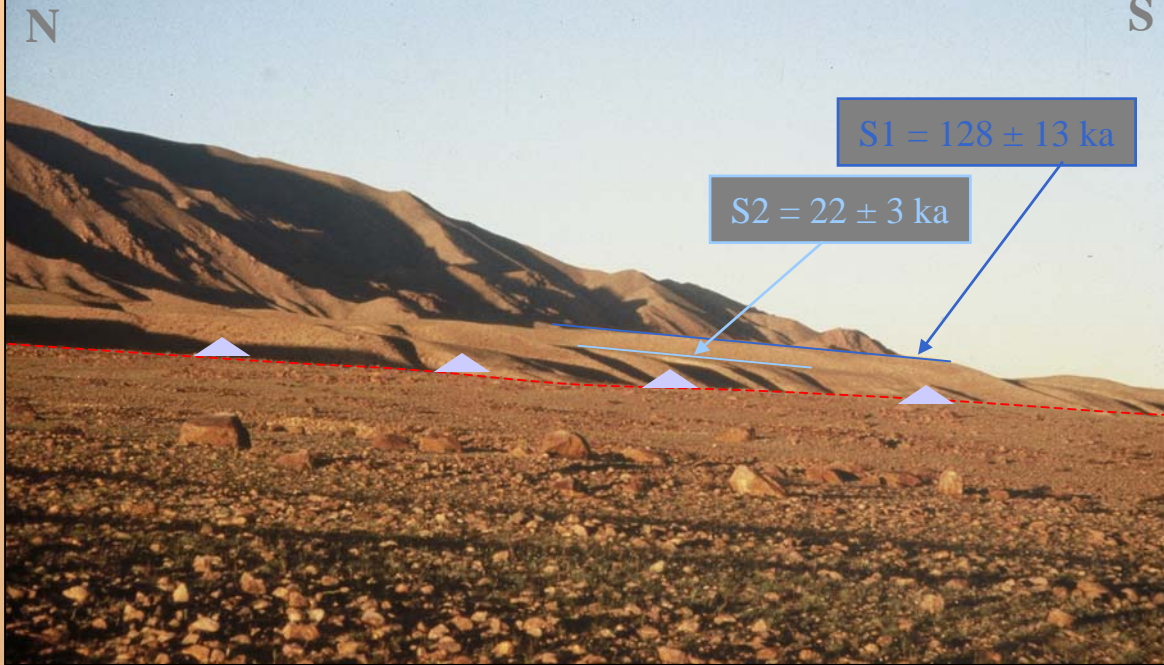


**Failles inverses:  
déplacement cumulé**

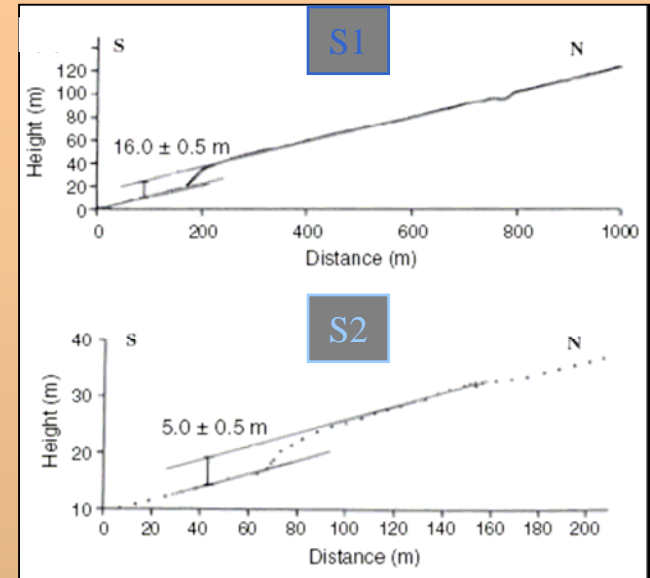
Gobi-Altay, Mongolie



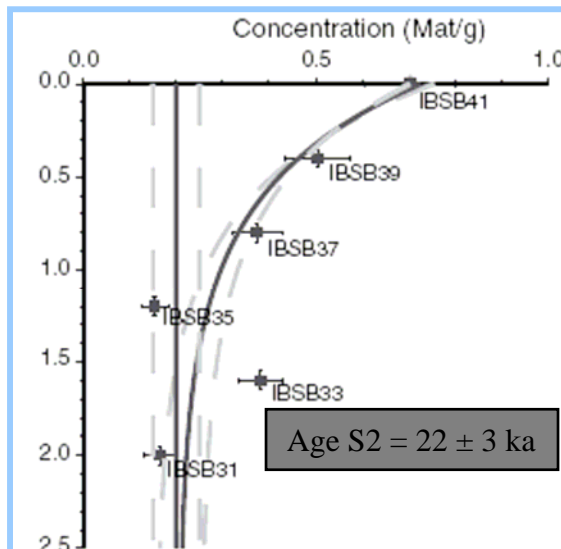
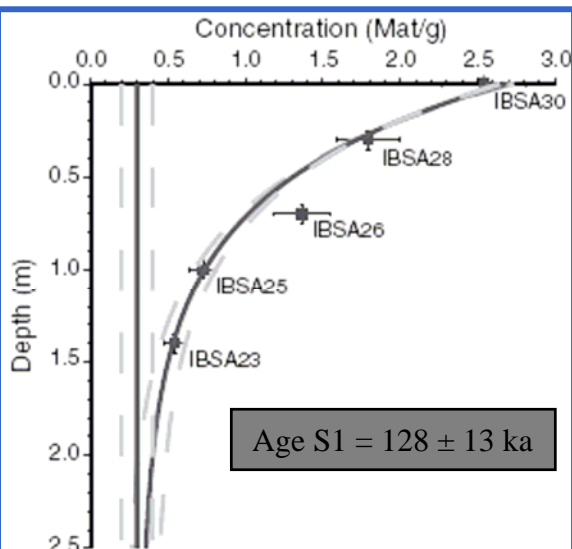
# Faïlle inverse de Gurvan Bulag, Gobi-Altay, Mongolie



## Profils topographiques traversant l'escarpement de faille



## Datation des cônes S1 et S2 par <sup>10</sup>Be cosmogénique



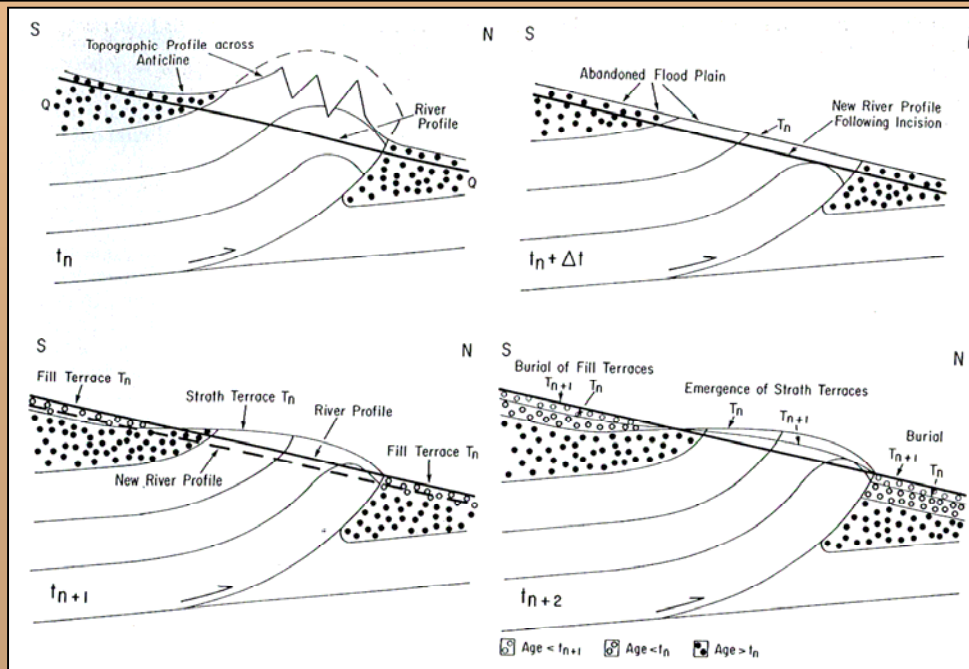
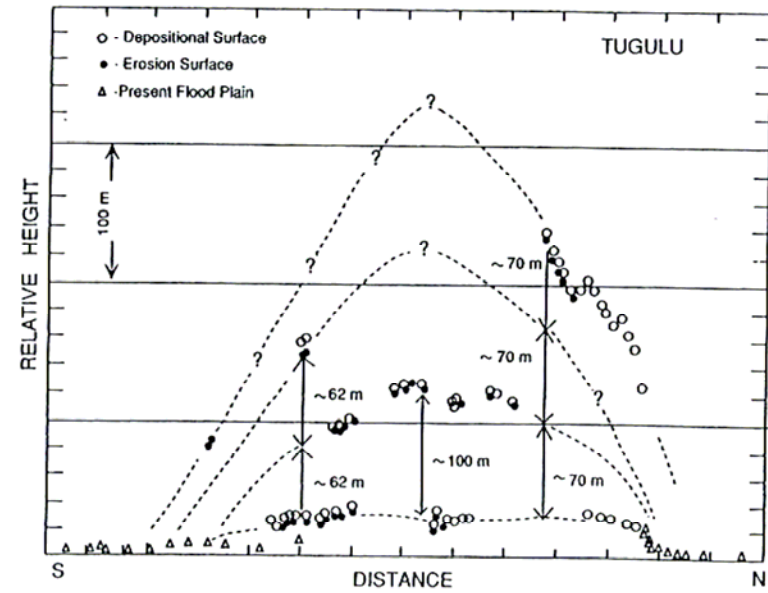
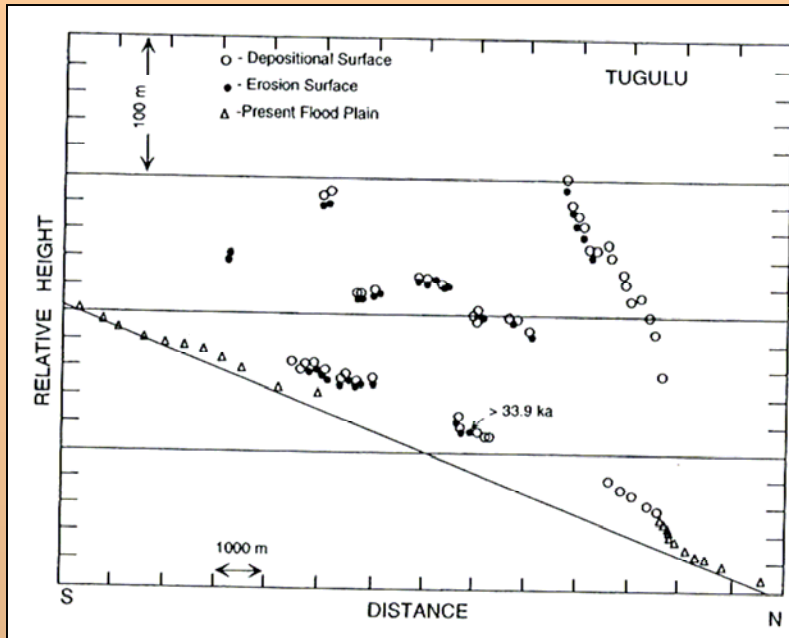
## Vitesse verticale de la faille:

Sur 130 ka:  $0,13 \pm 0,02$  mm/an

Sur 20 ka:  $0,23 \pm 0,05$  mm/an

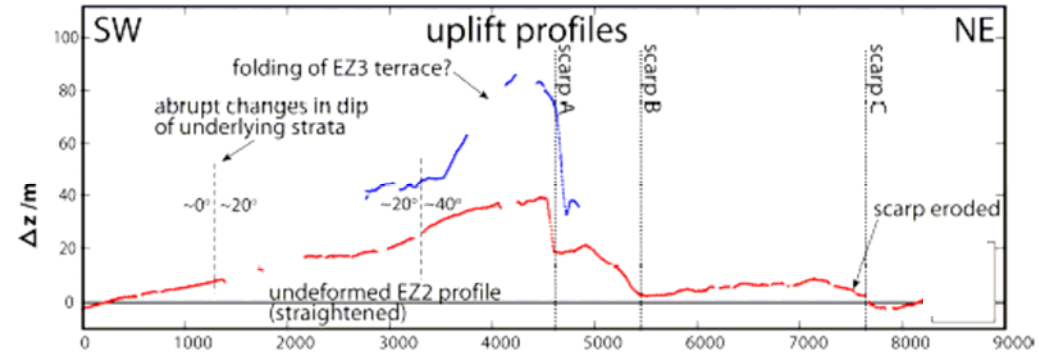
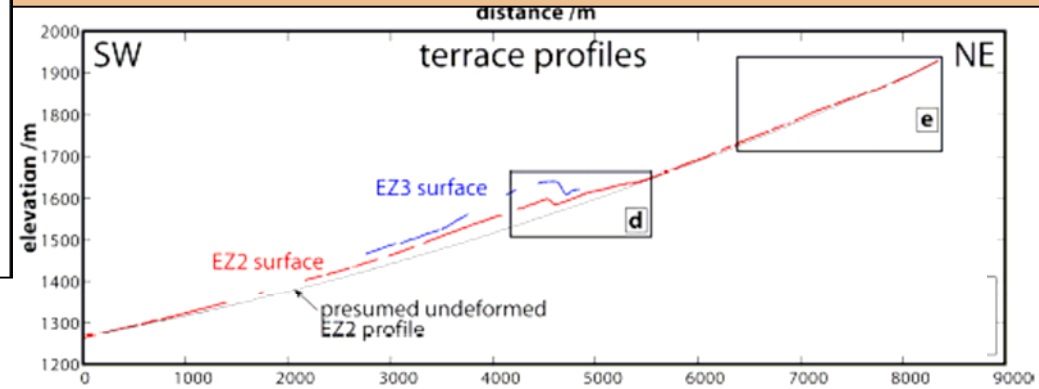
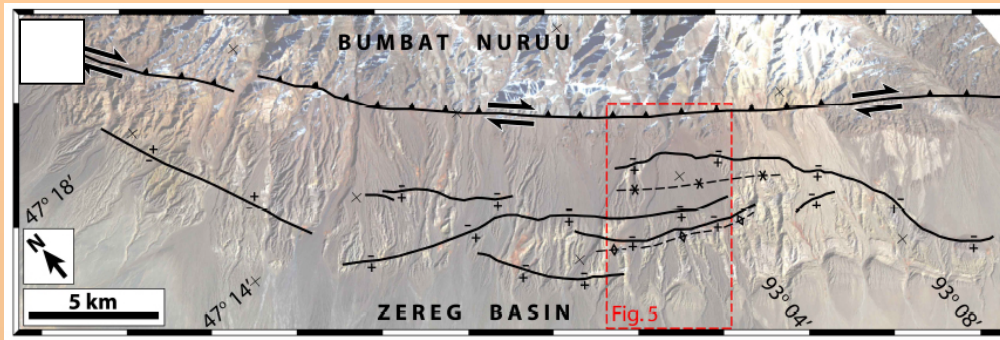
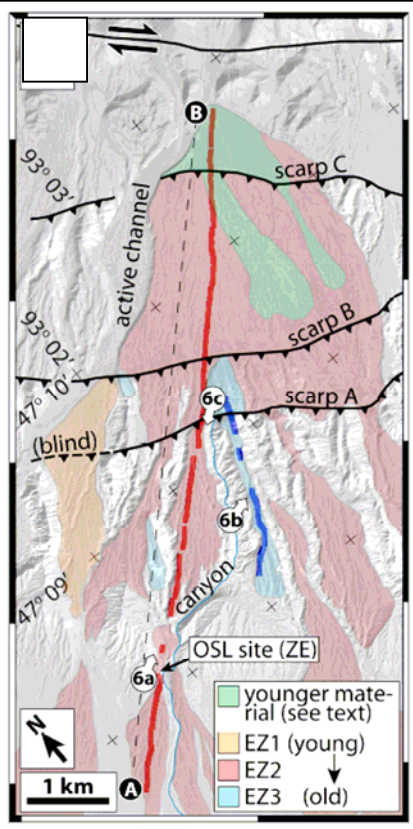
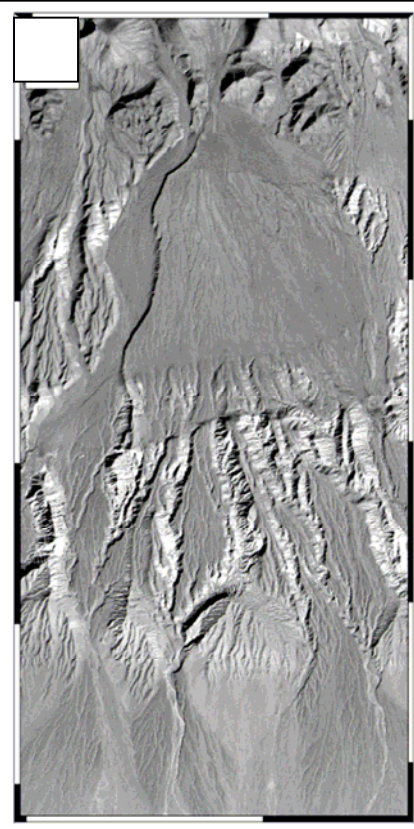
La vitesse a sensiblement augmenté sur les derniers 20 ka

# Terrasses marqueurs du plissement



Molnar et al., 1994



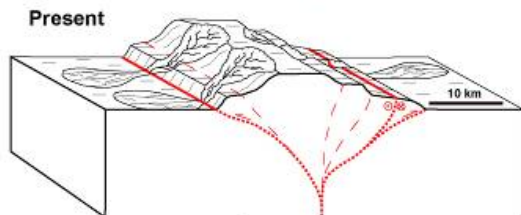
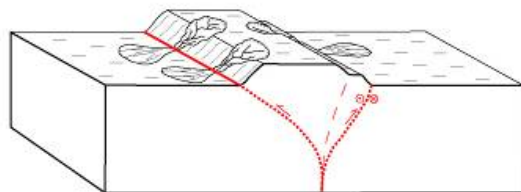
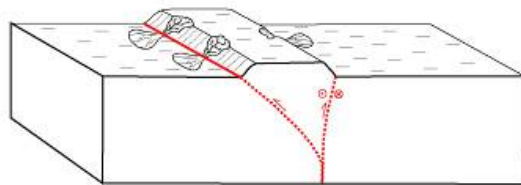
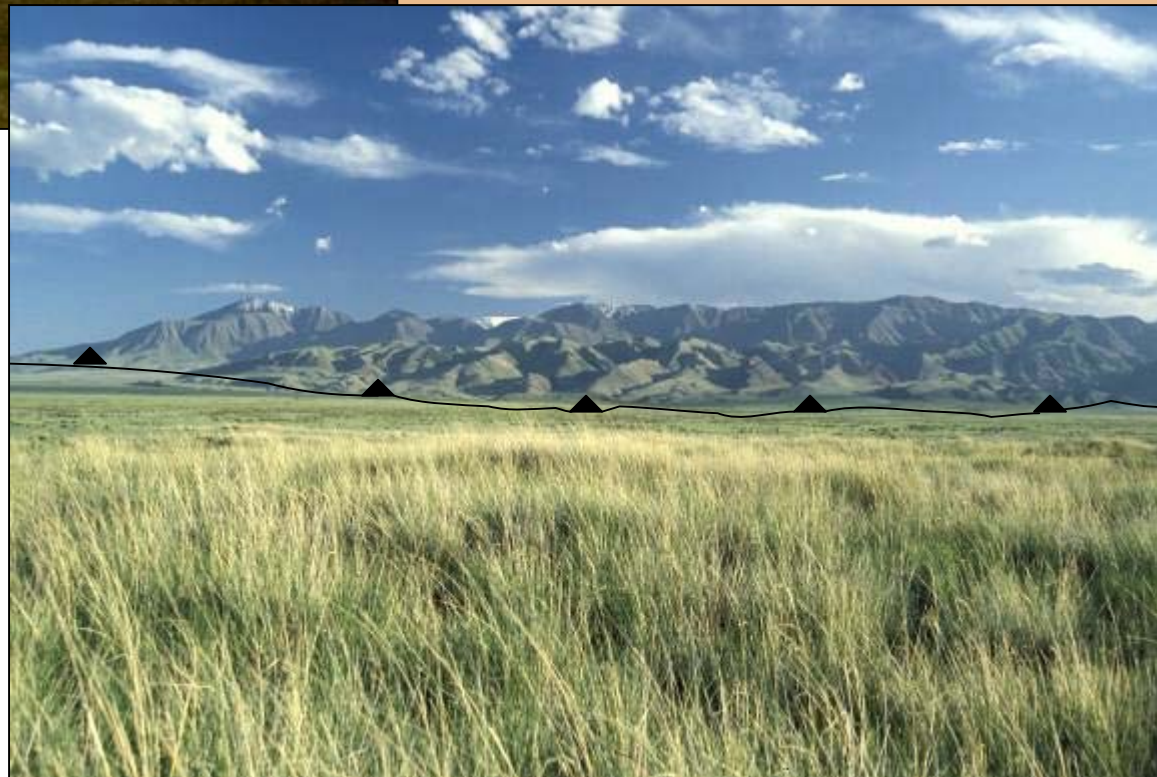


Plissement ou érosion différentielle?

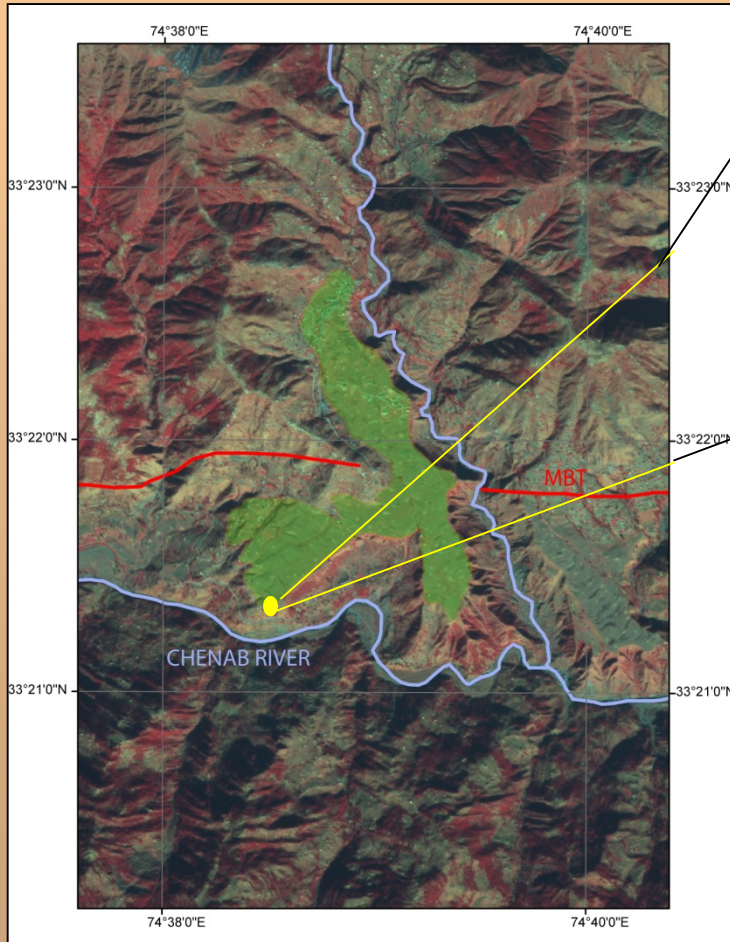
# Activité long terme: Surrection de massifs

Ih Bogd, Gobi-Altay

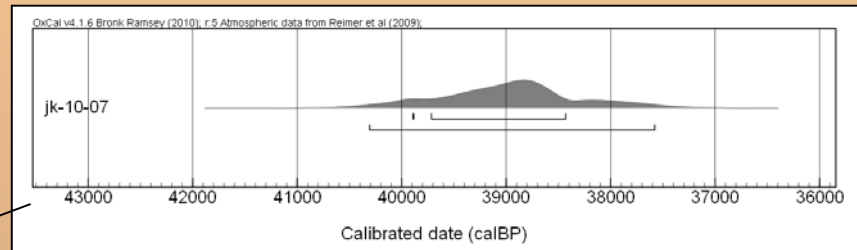
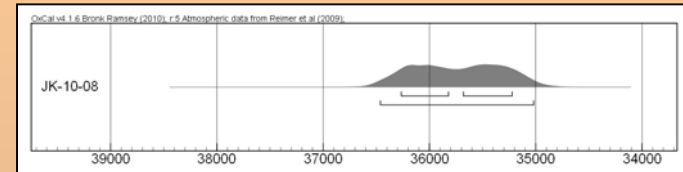
Sutai Uul, Altay



# Terrasses qui scellent le mouvement d'une faille active

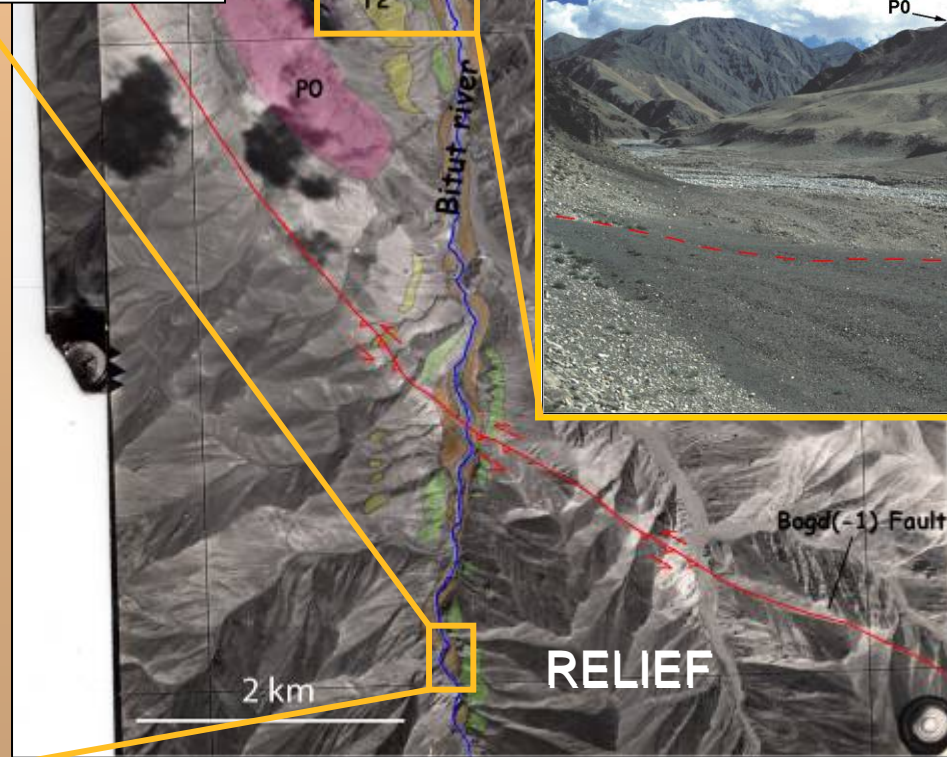
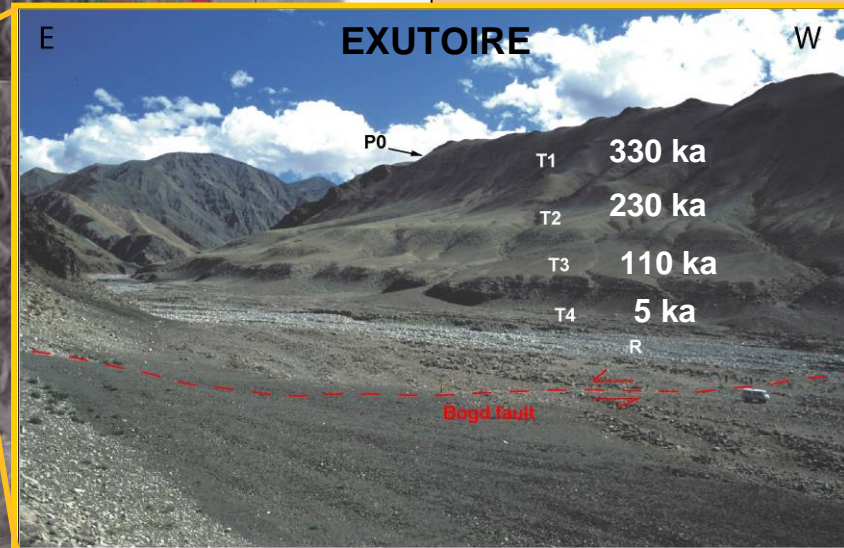
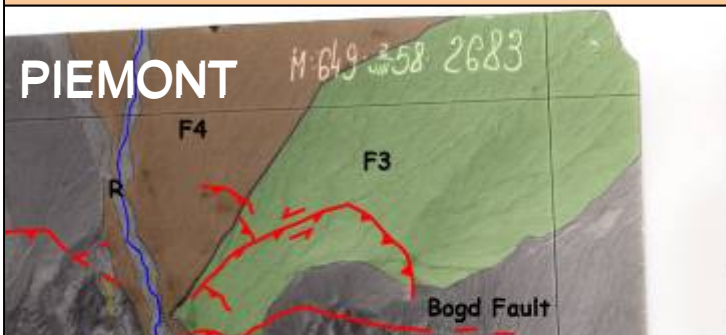
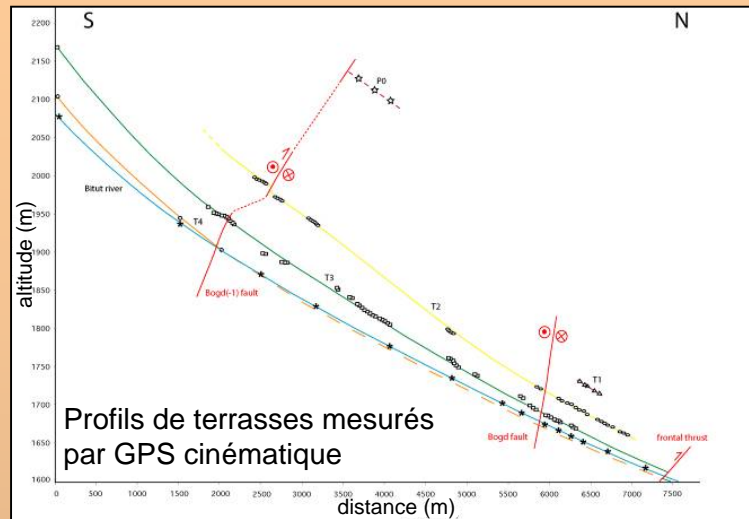


14 C Samples

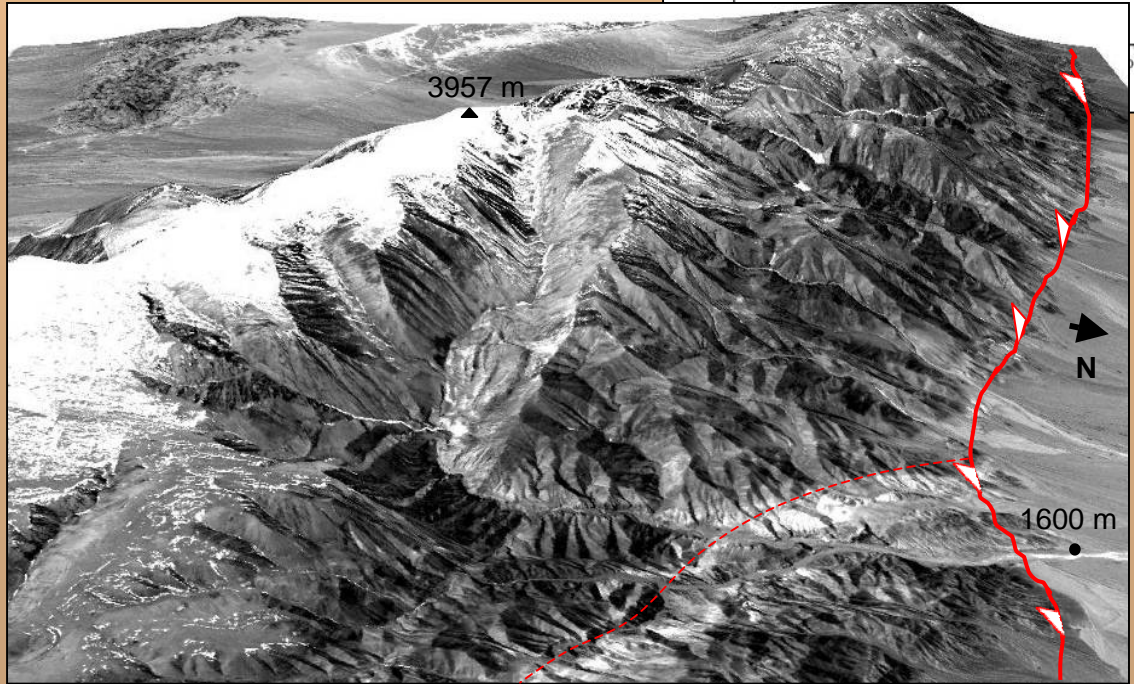
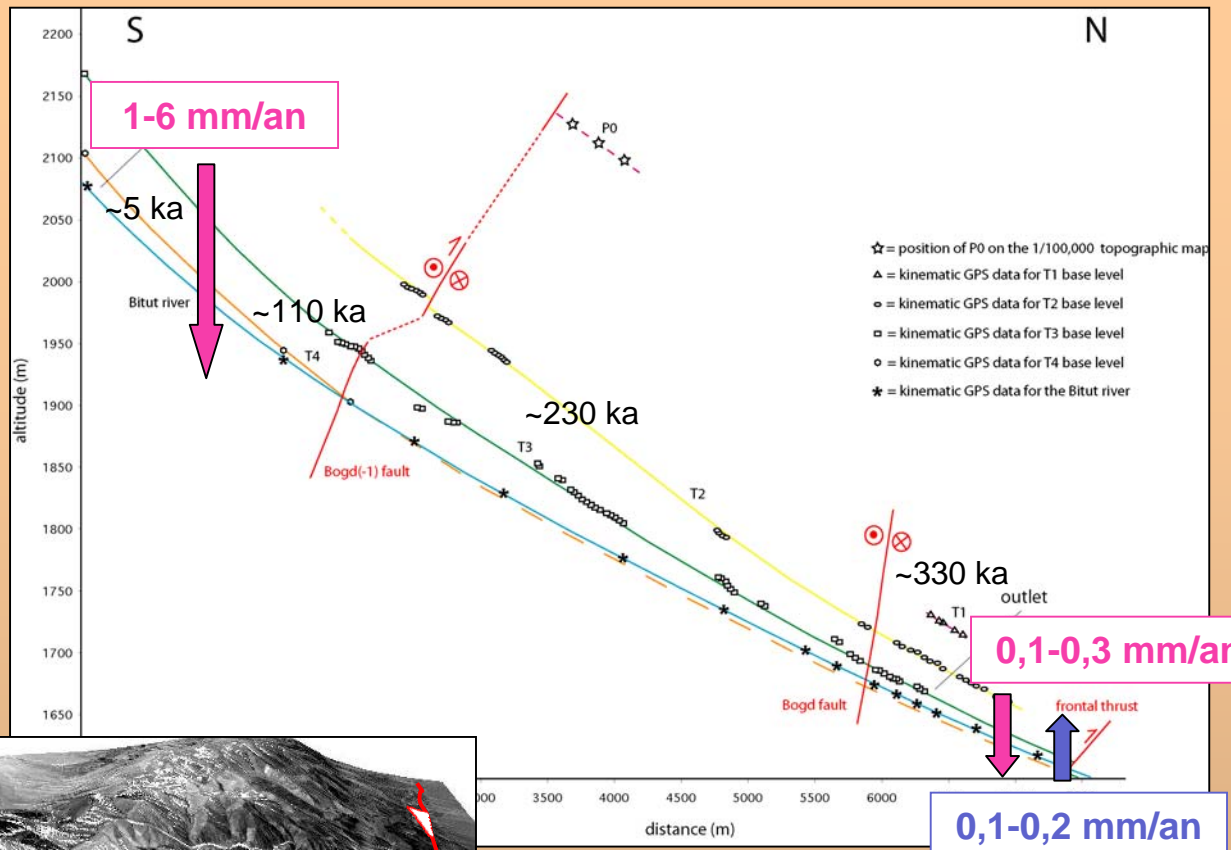
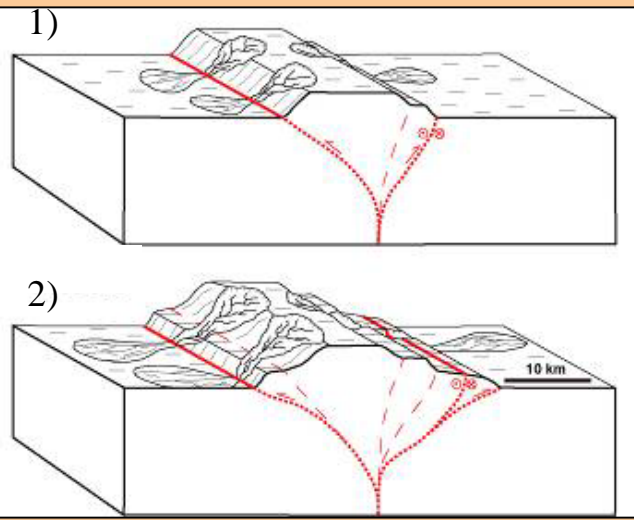


Vignon et al., 2010

# Terrasses marqueurs de la migration de la déformation

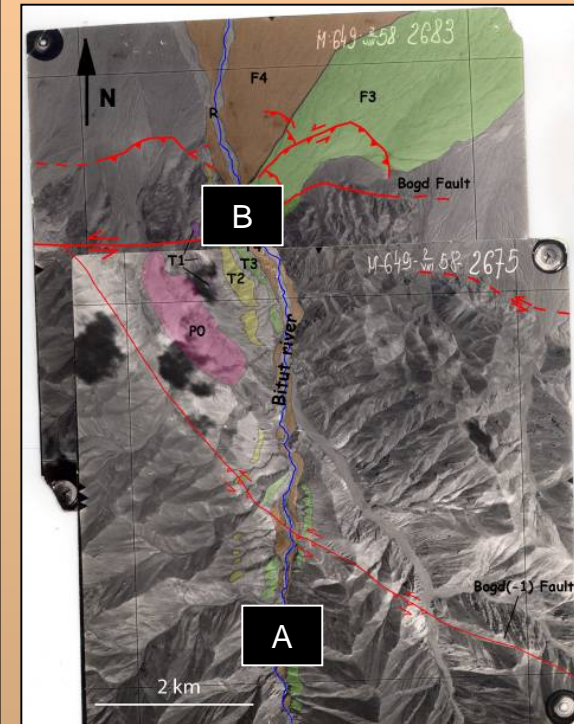
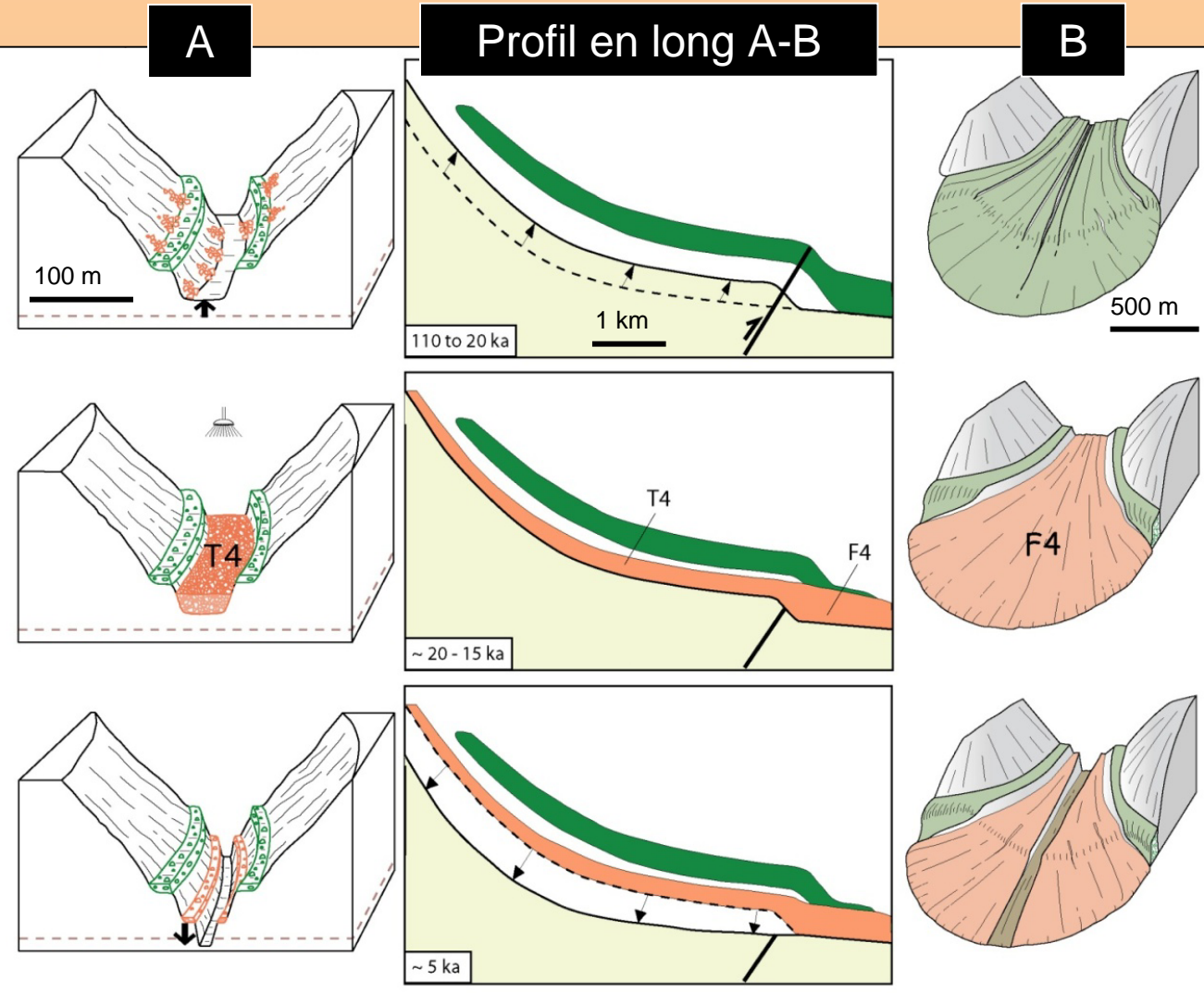


Gobi-Altay, Mongolie



Vassallo et al., 2007

# Chronologie et mode de formation de ces terrasses vis-à-vis de la surrection

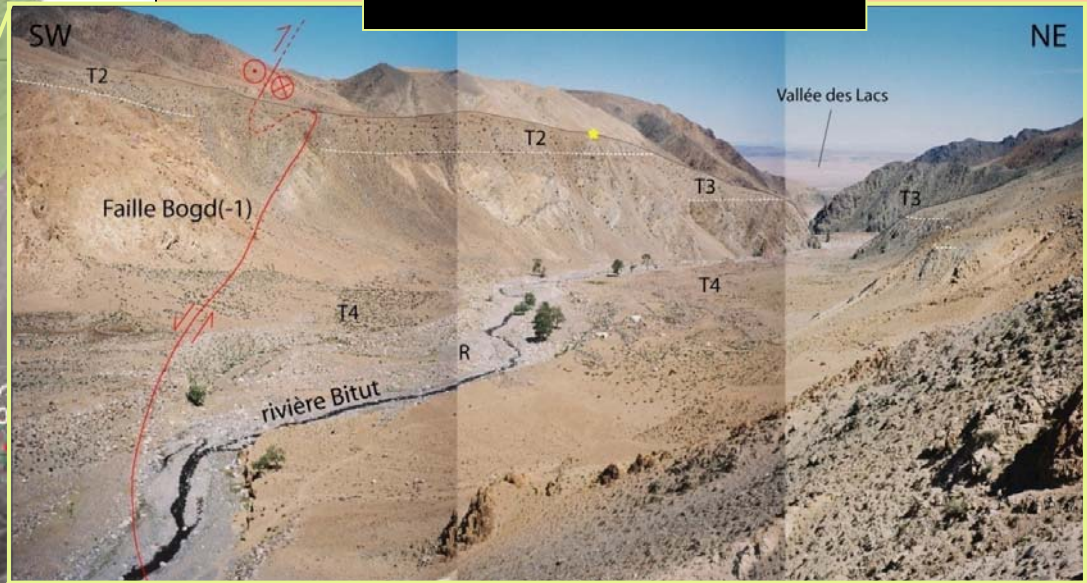


Vassallo et al., 2007

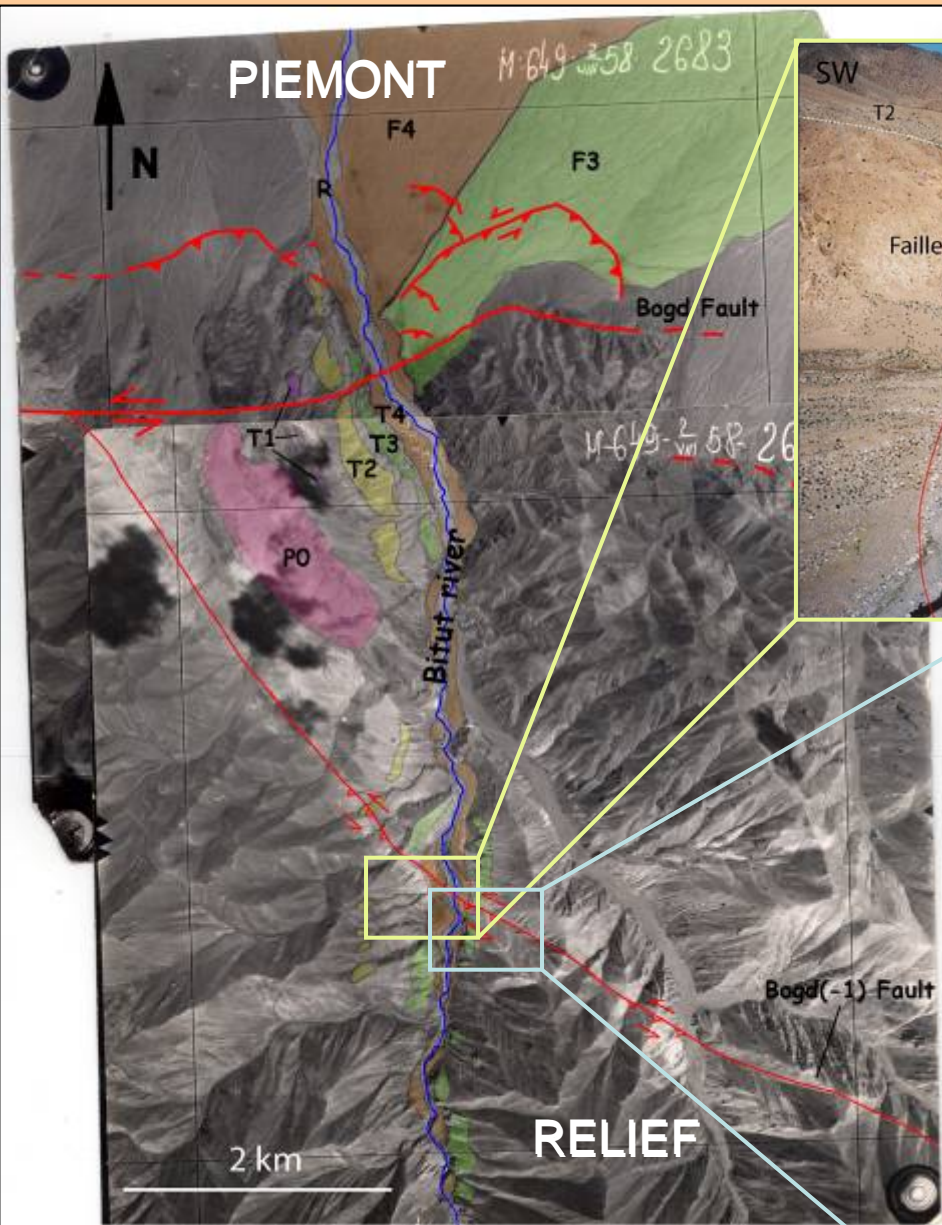
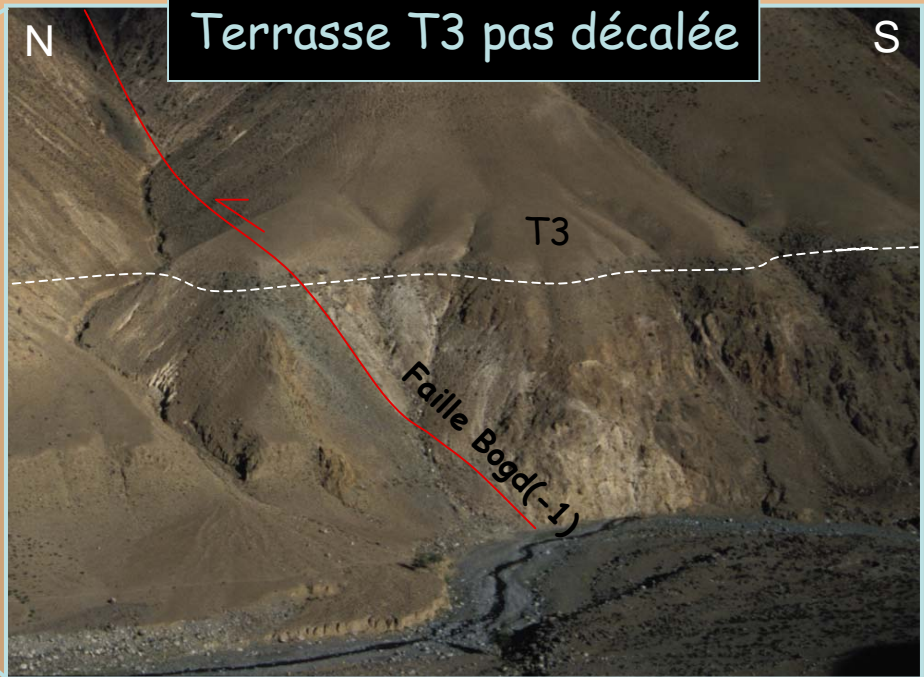
## INCISIONS

- Plus rapides que le taux de surrection
- Périodiques et localisées dans le temps
- Se propagent vers l'amont en quelques ka

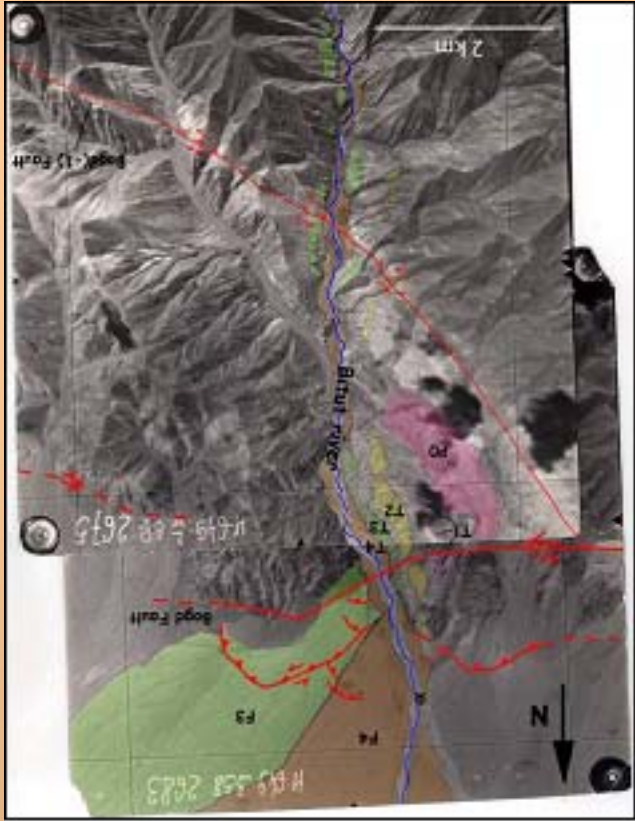
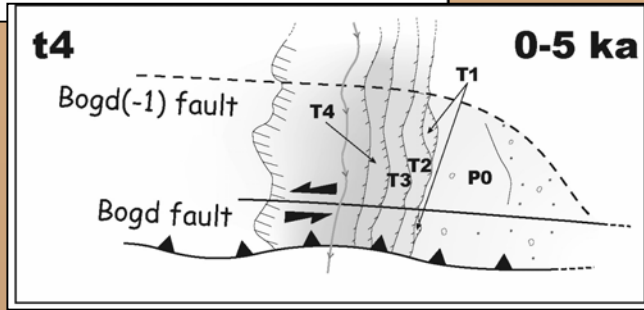
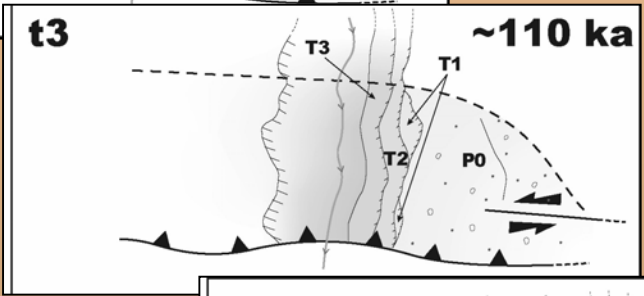
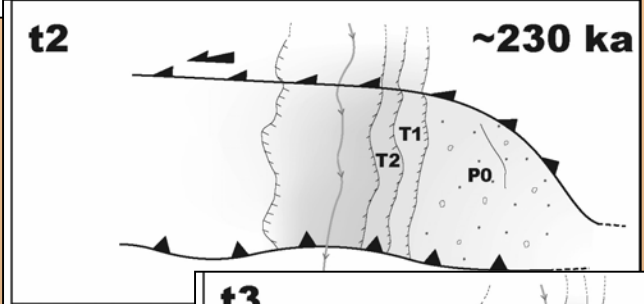
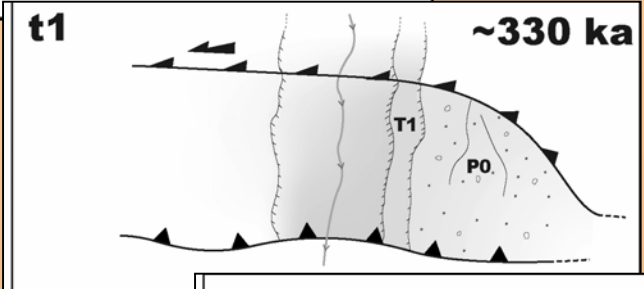
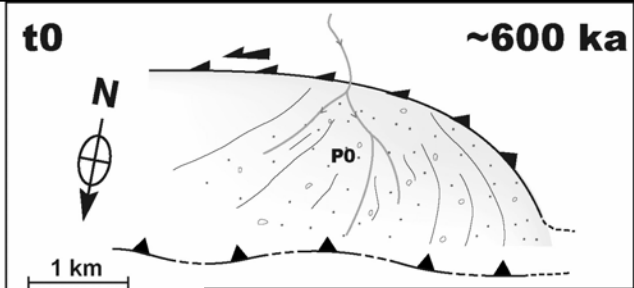
Terrasse T2 décalée



Terrasse T3 pas décalée



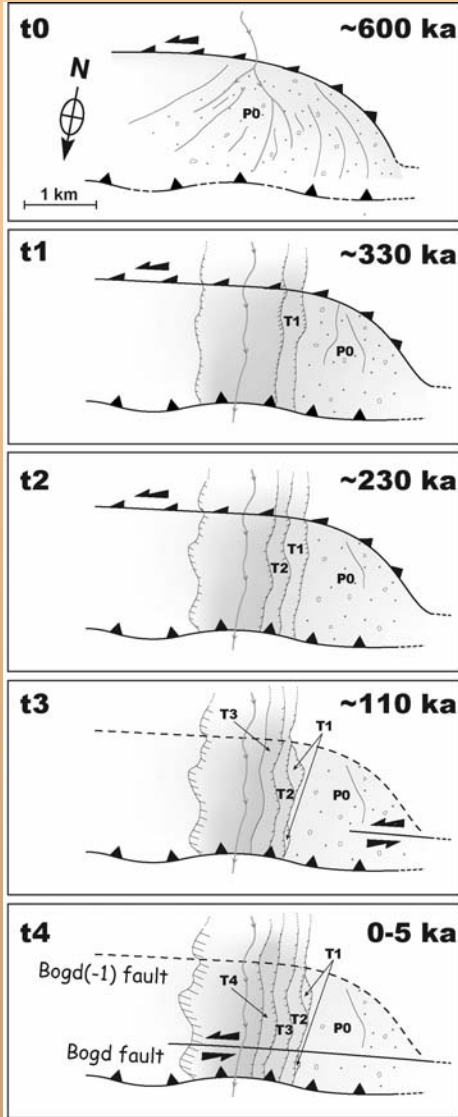
# Migration de la déformation au cours du temps





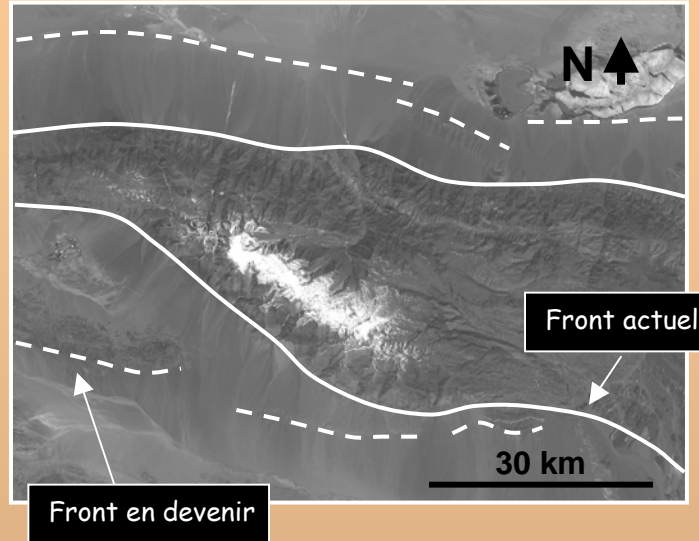
# Evolution de la déformation à différentes échelles

## Bassin versant



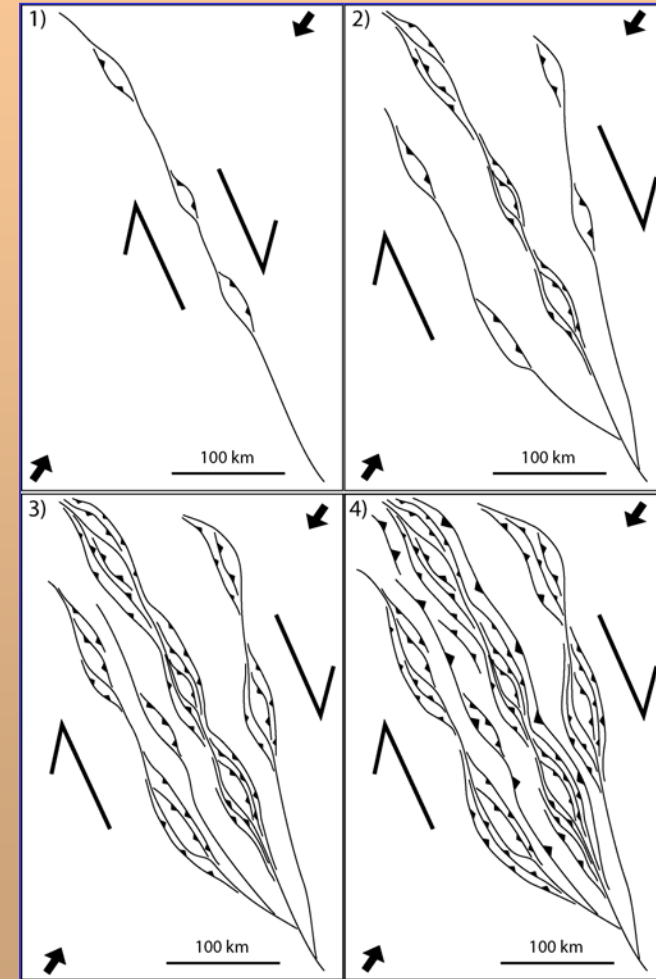
< 1 Ma

## Massif



1-10 Ma

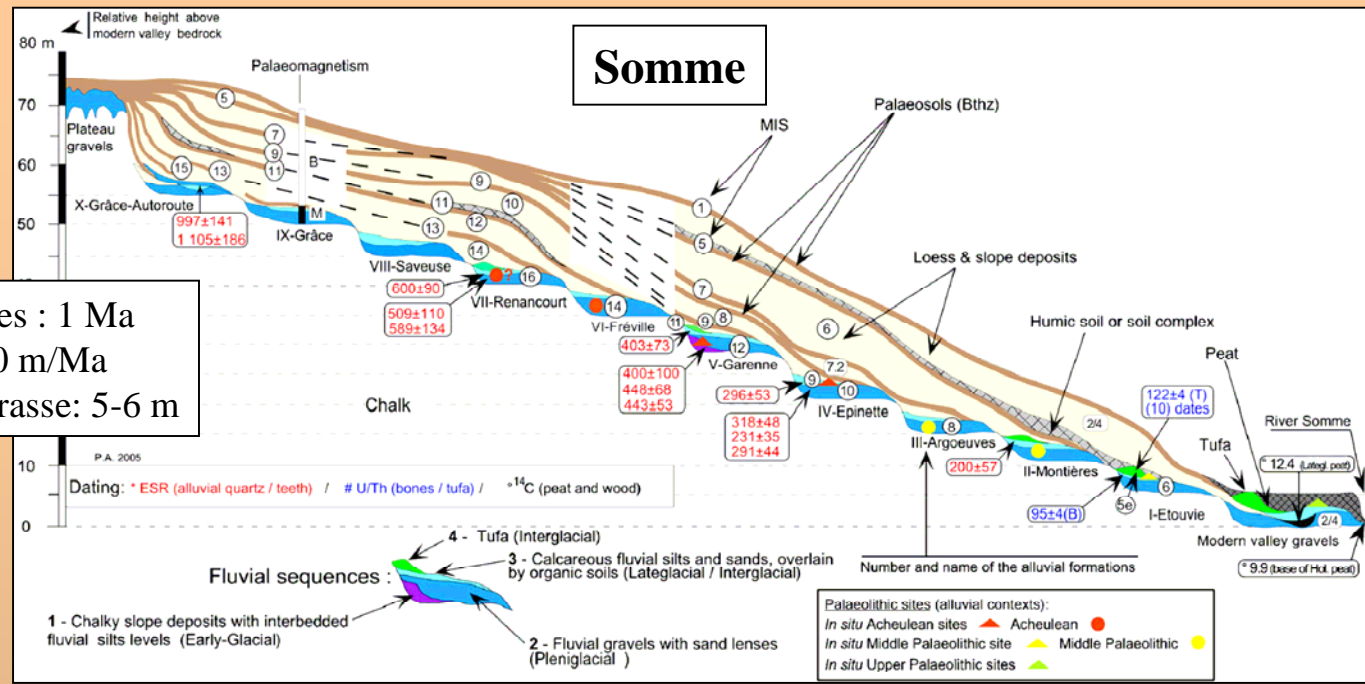
## Chaîne de montagne



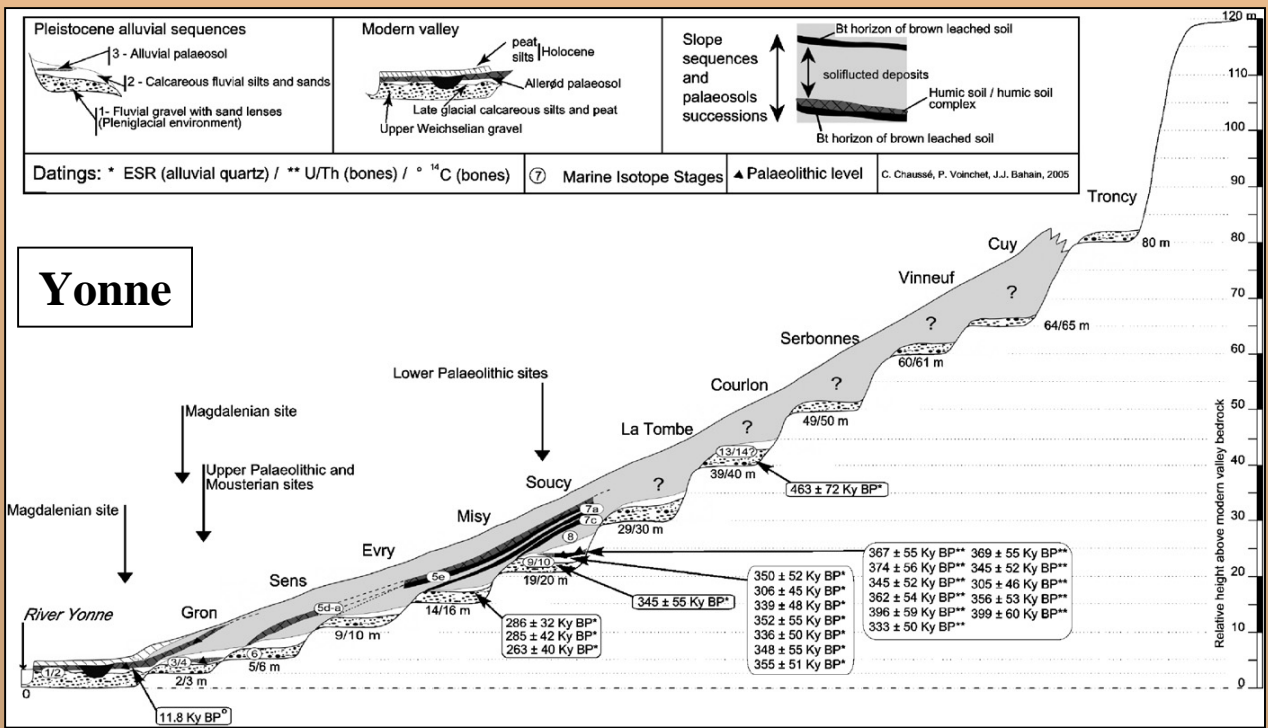
10-100 Ma

# Moteur des incisions dans le Bassin Parisien

Terrasses plus anciennes préservées : 1 Ma  
 Taux de surrection régional: 50-60 m/Ma  
 Incision verticale entre chaque terrasse: 5-6 m



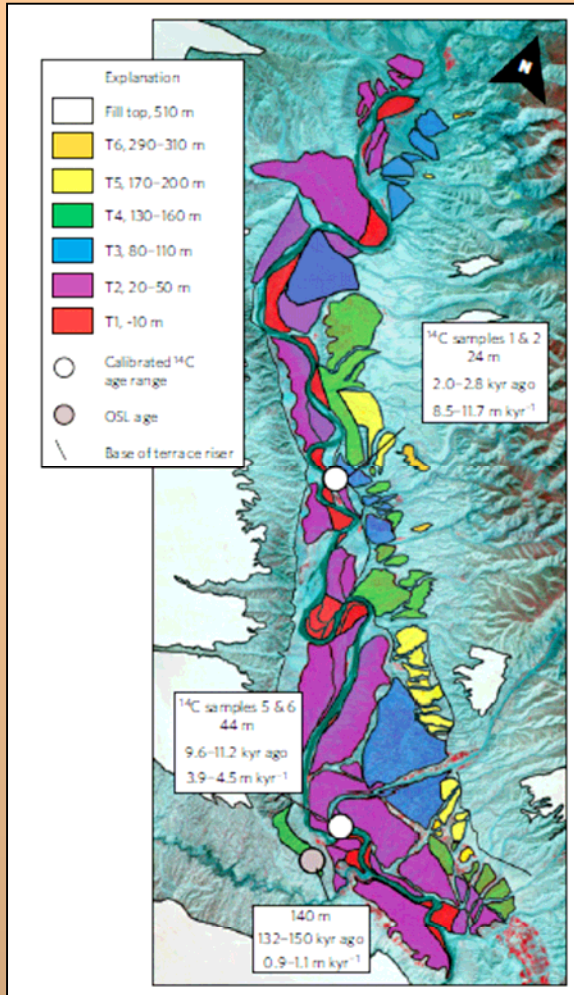
Antoine et al., 2007



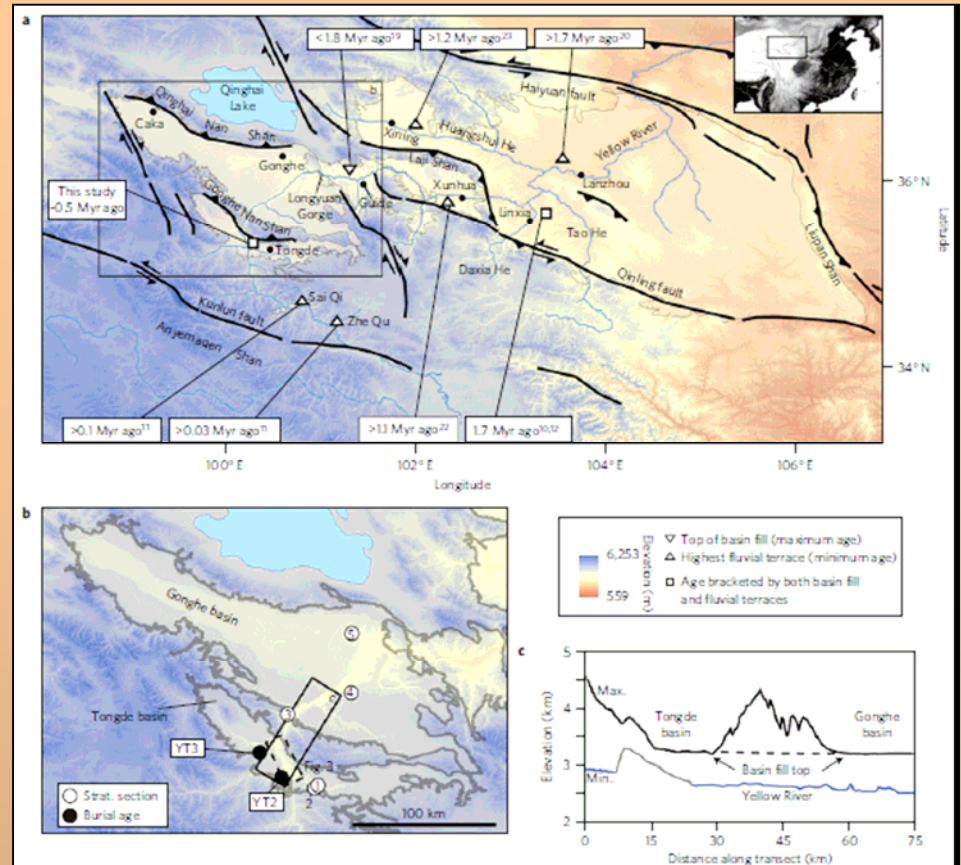
**INCISIONS**

- Potentiel créé par le soulèvement régional
- Timing contrôlé par le climat
- Localisées au début des périodes froides

# Soulèvement du Tibet et incision



Craddock et al.,  
2010

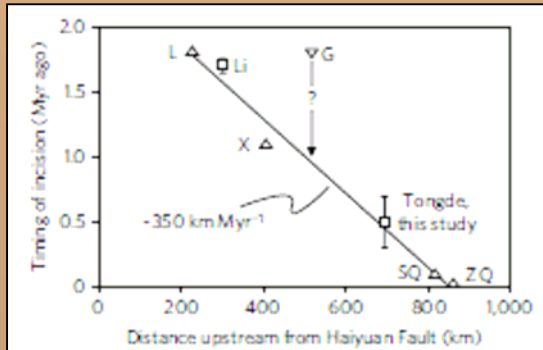


Surrection des chaînes de montagnes au NE du plateau tibétain : Miocène (14-8 Ma)

Début de l'incision du Fleuve Jaune sur le bord du plateau : Quaternaire (1.8 Ma)

Ligne de crête recule à une vitesse de 350 km/Ma

**Forte augmentation (facteur 10) du taux d'incision tardi-holocène indépendant de la vitesse de surrection (stable)**



# Soulèvement de l'Himalaya et incision



Marqueurs alluviaux abandonnés par l'incision de la même rivière dans le footwall et dans le hangingwall :  
Quantification de la surrection possible

Vignon et al., 2010

