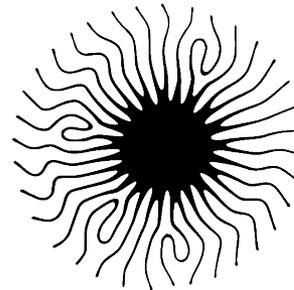


# *Danse & Chant des dunes*

Stéphane Douady



M  
S  
C



CENTRE NATIONAL  
DE LA RECHERCHE  
SCIENTIFIQUE

UNIVERSITÉ  
PARIS 7 - DENIS DIDEROT





**Rub al-Khali,  
Sultanat d'Oman**



**Fougoutir,  
Maroc**

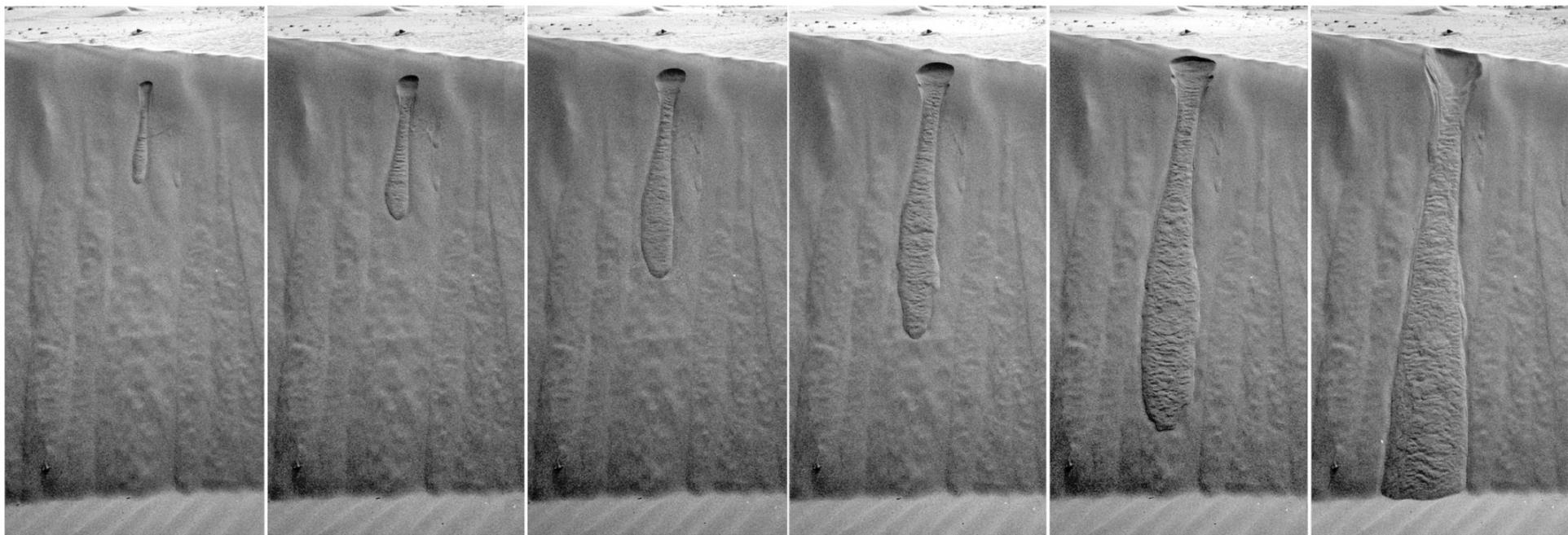
Formes « organiques »



Transport & déposition

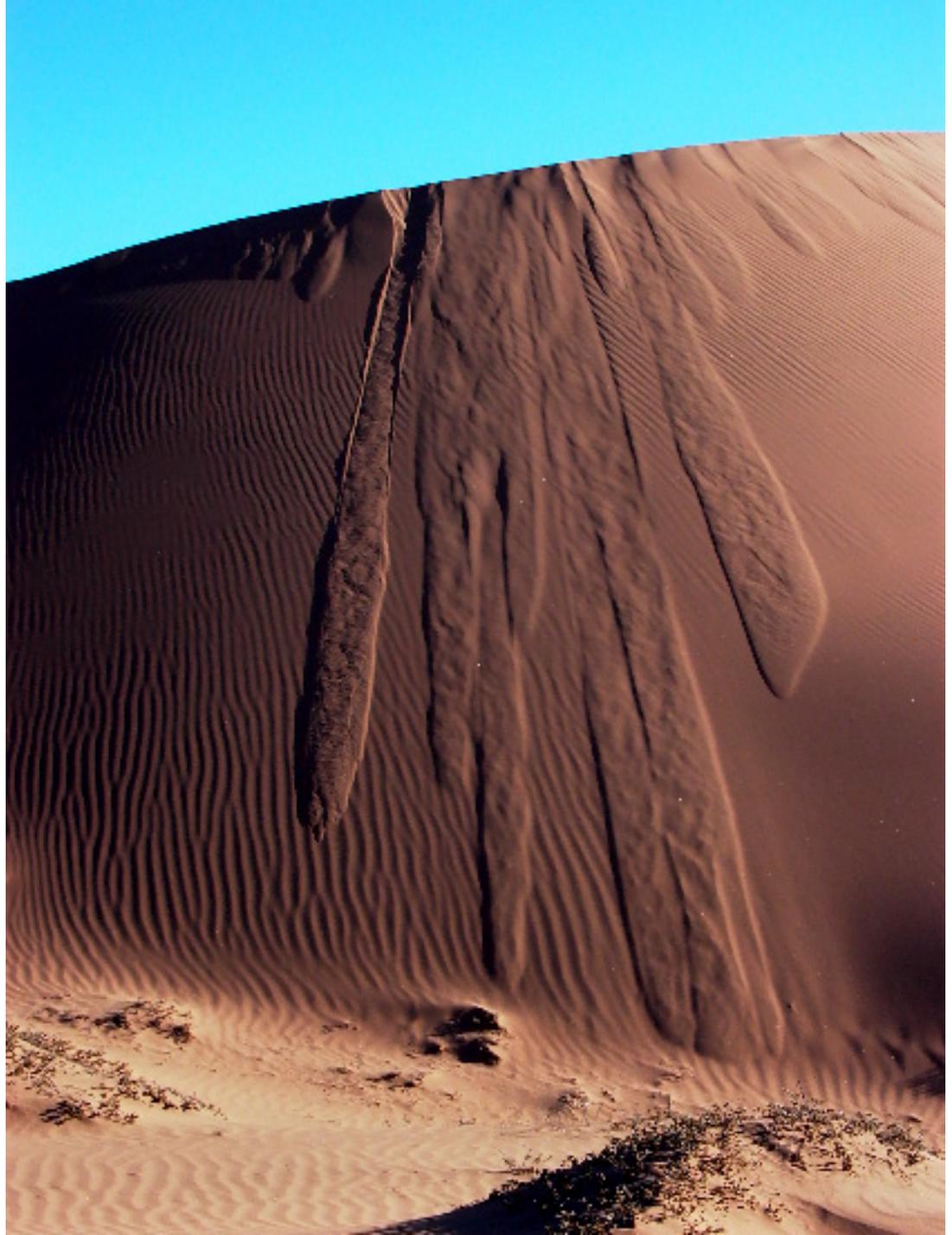


Boundary layer take-off



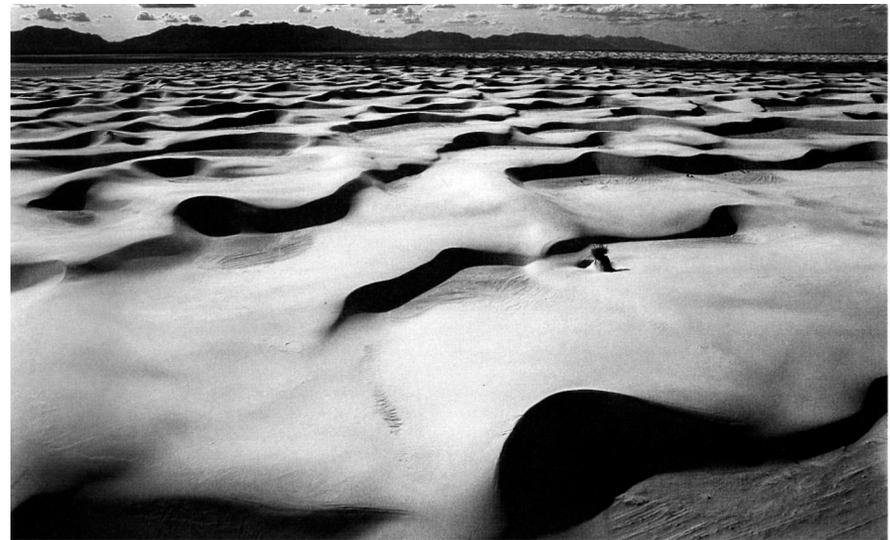
Avalanche

(Chilean avalanches)





Barkhane



Dunes transverses



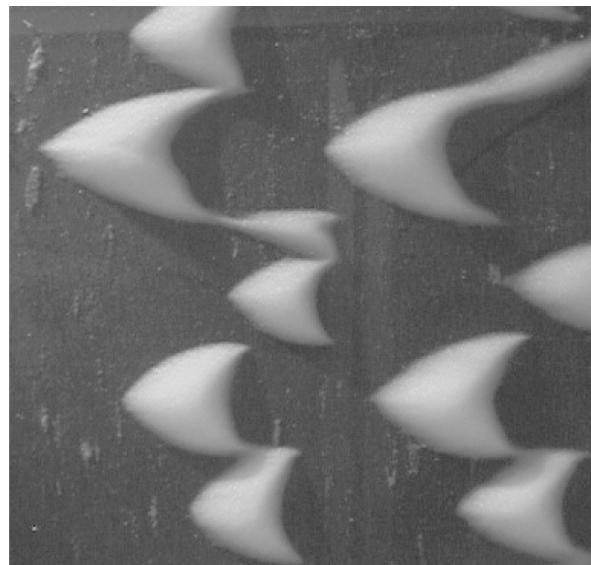
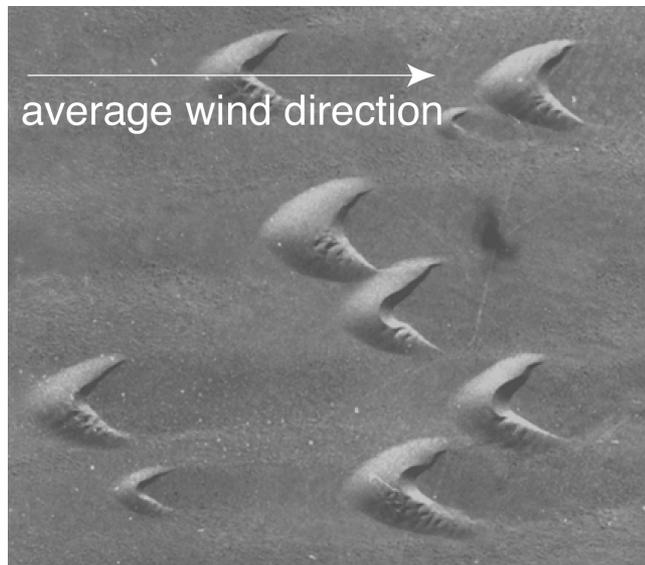
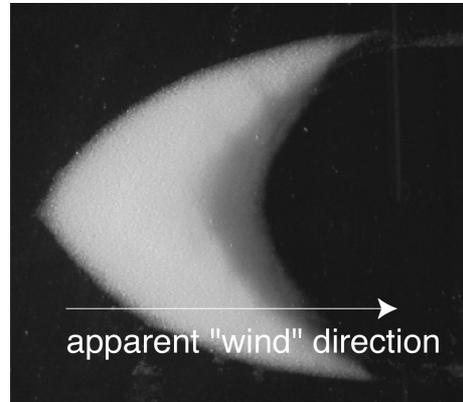
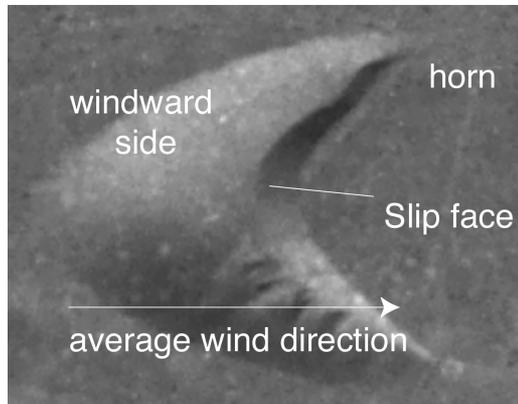
(Barkhanes chiliennes)



minimum size...

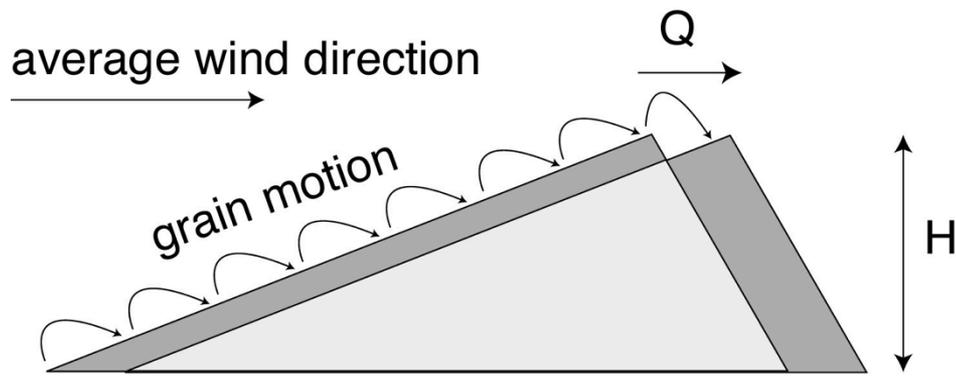


**Pascal Hersen**



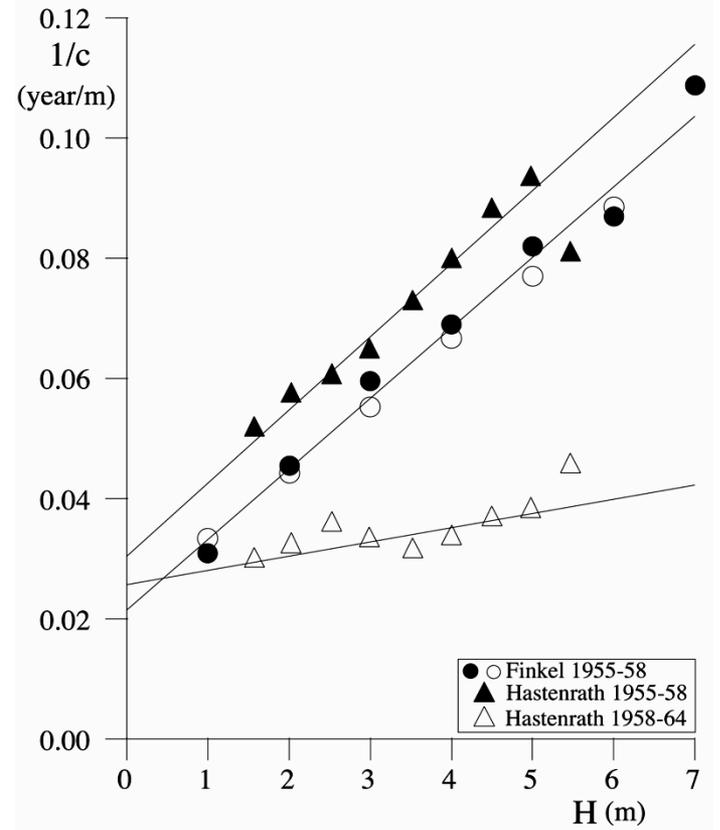
aeolian dune field

aquatic dune field



$$LH = QT$$

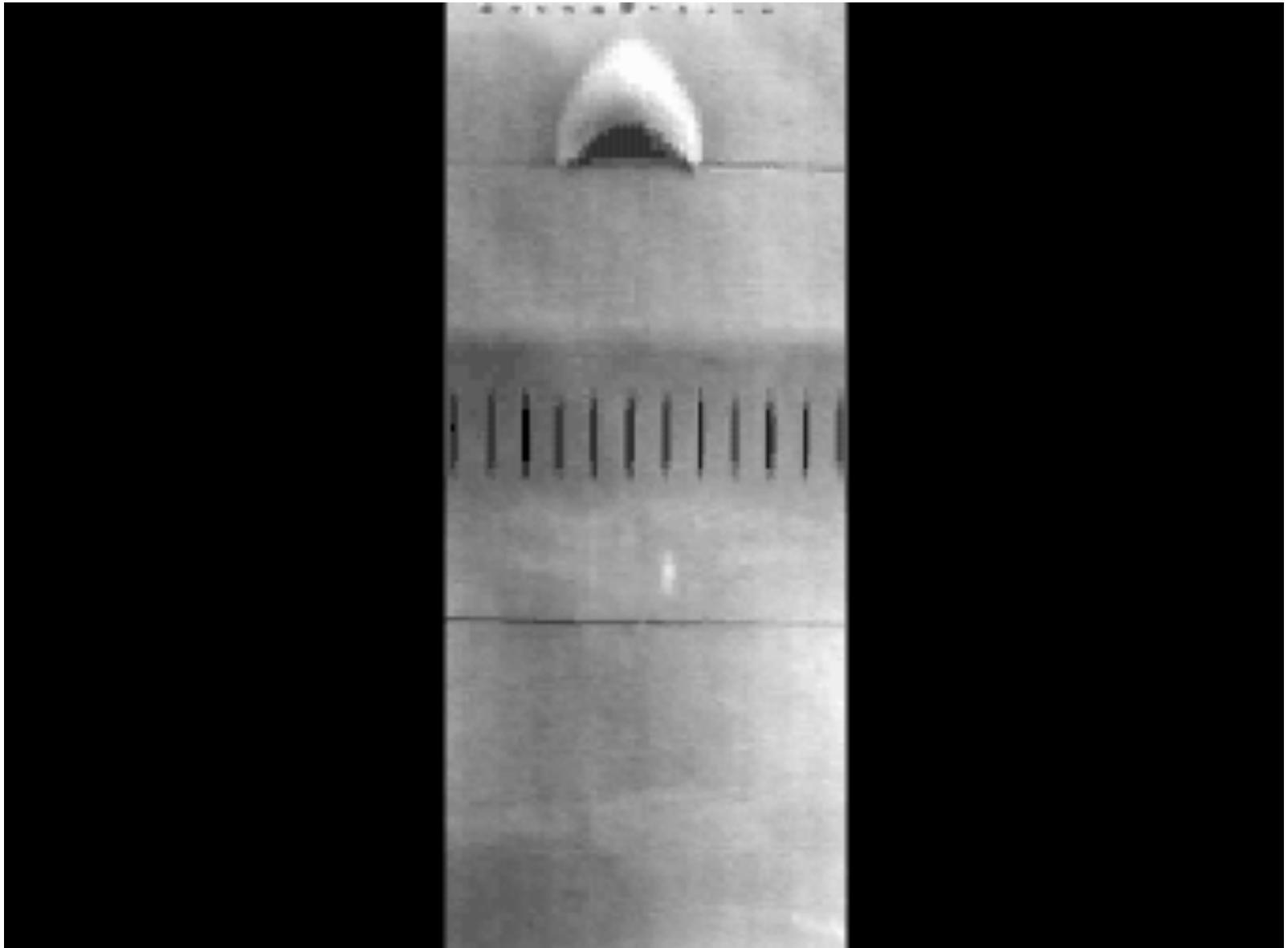
$$C = Q/H$$

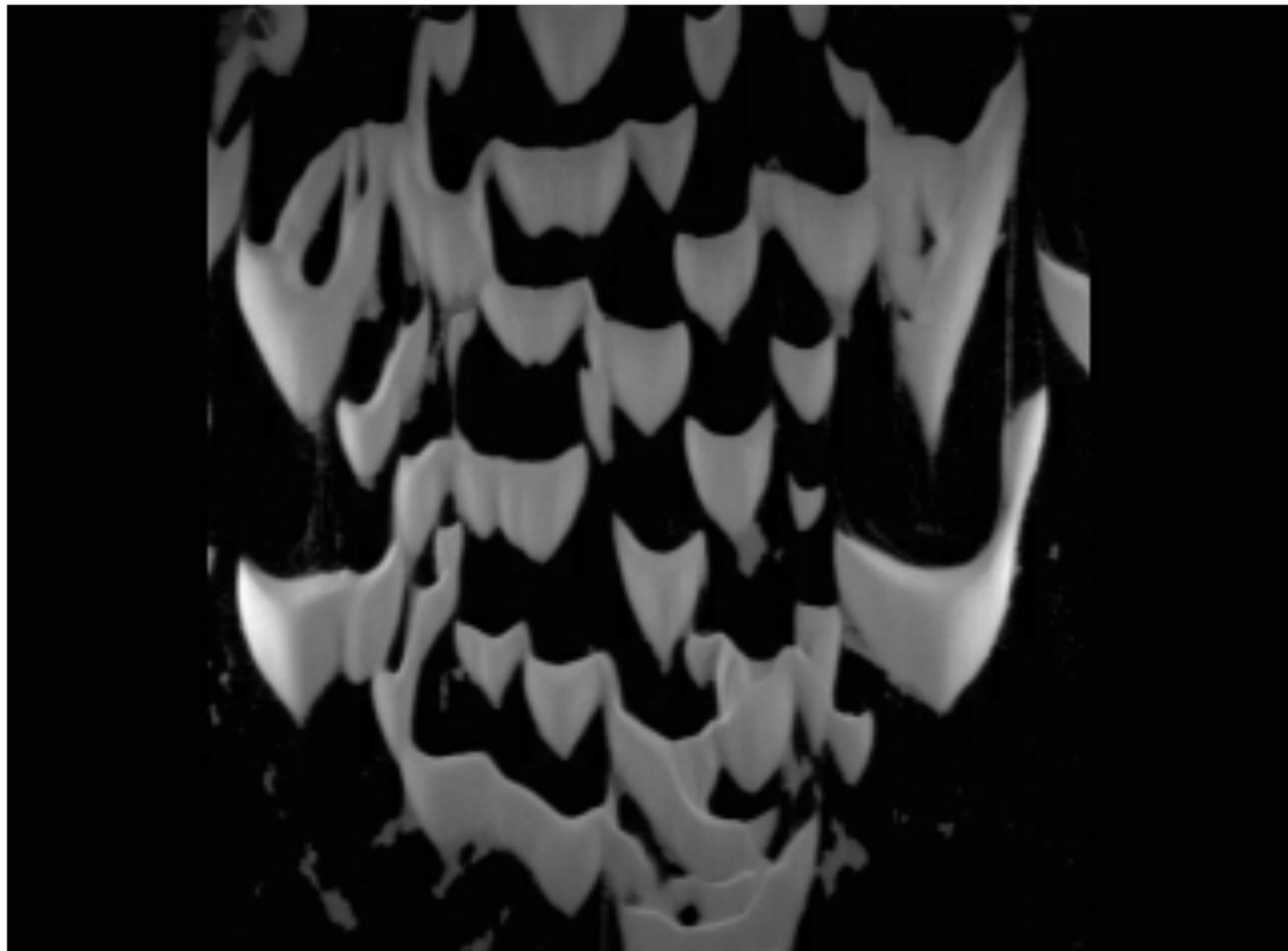


**Bagnold 1954**

# Course de dunes



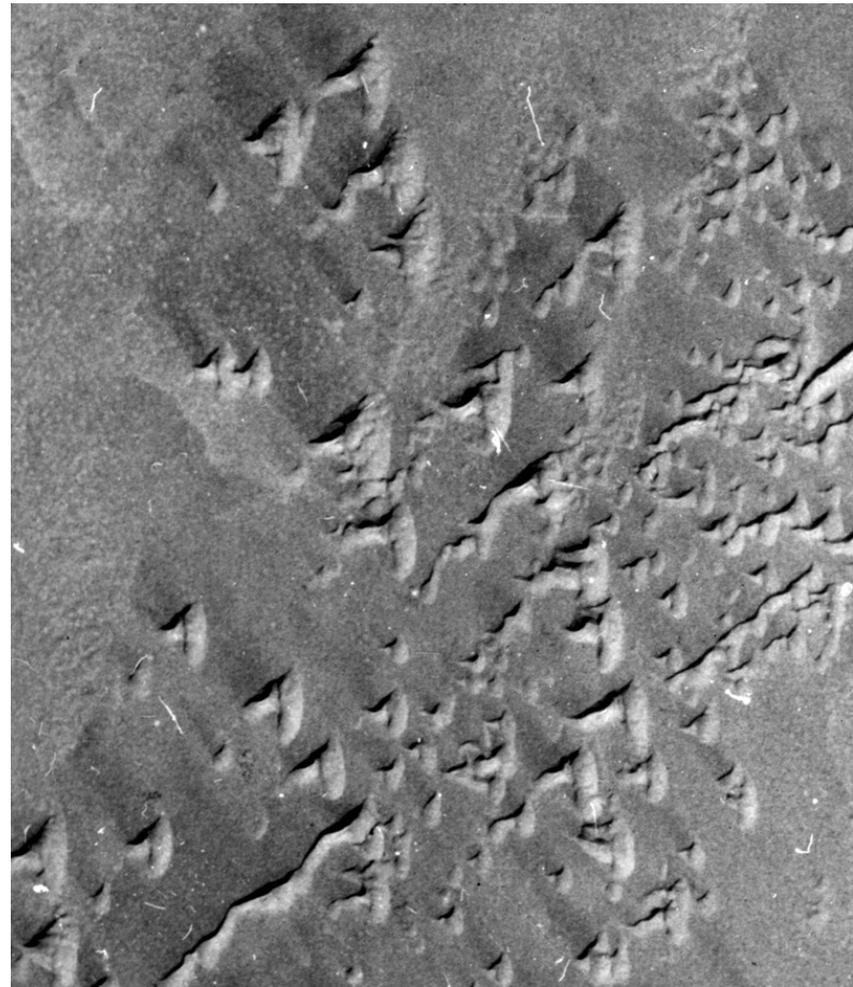






Retournement

Wind changes...





# Le chant des dunes





Variation 1/2 ton



Rugueux/pur

**(B59)**

# 1D, 2D, 3D Instruments



cordes

colle-glisse  
(archet)



percussions



vents

Von Karmann  
Bernoulli

« grincement » de l'archet sur la corde



Corde excitée par le mouvement périodique de colle-glisce



Idem « grincement » de porte

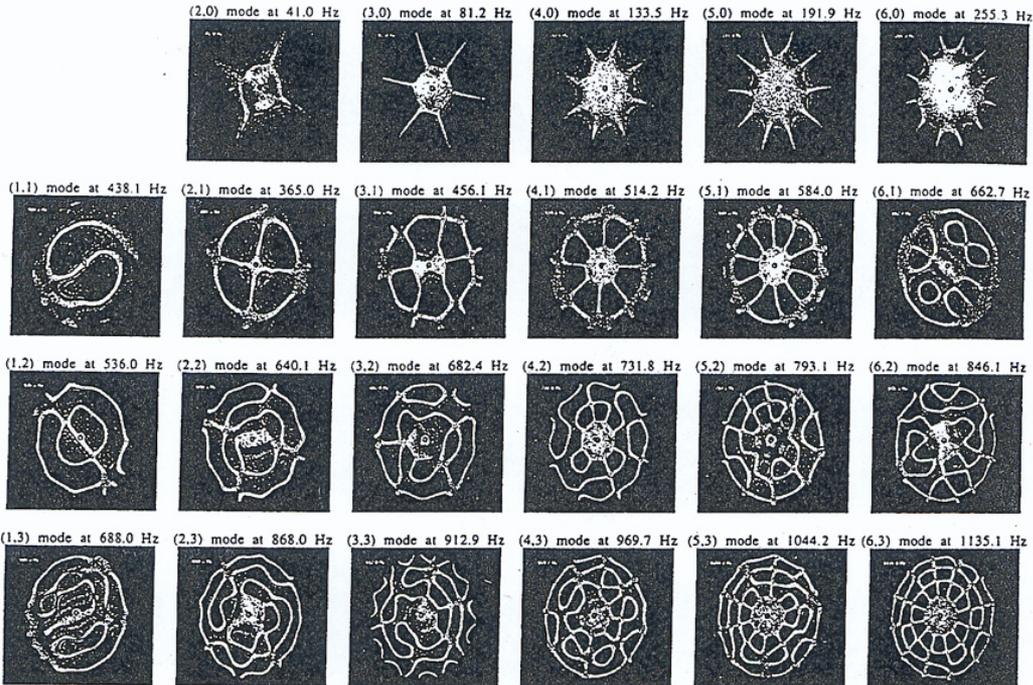


Fig. 9.1. Vibrational modes of a 46-cm diameter medium crash cymbal [2].



### Comparaison Cymbale/plaque

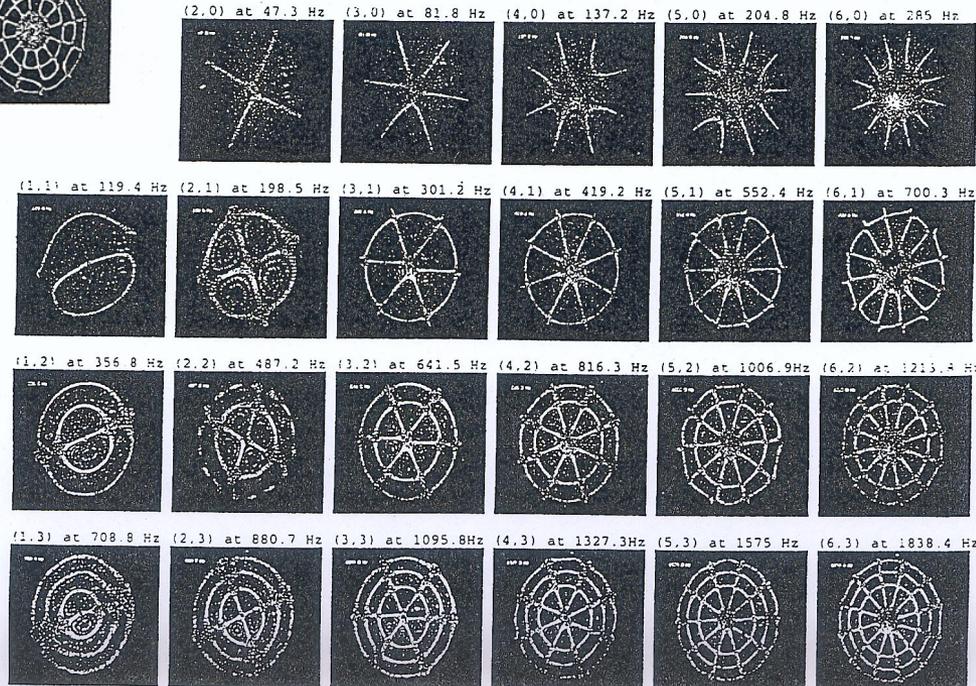


Fig. 9.2. Vibrational modes of a 46-cm diameter flat plate [2].

Wind Instruments

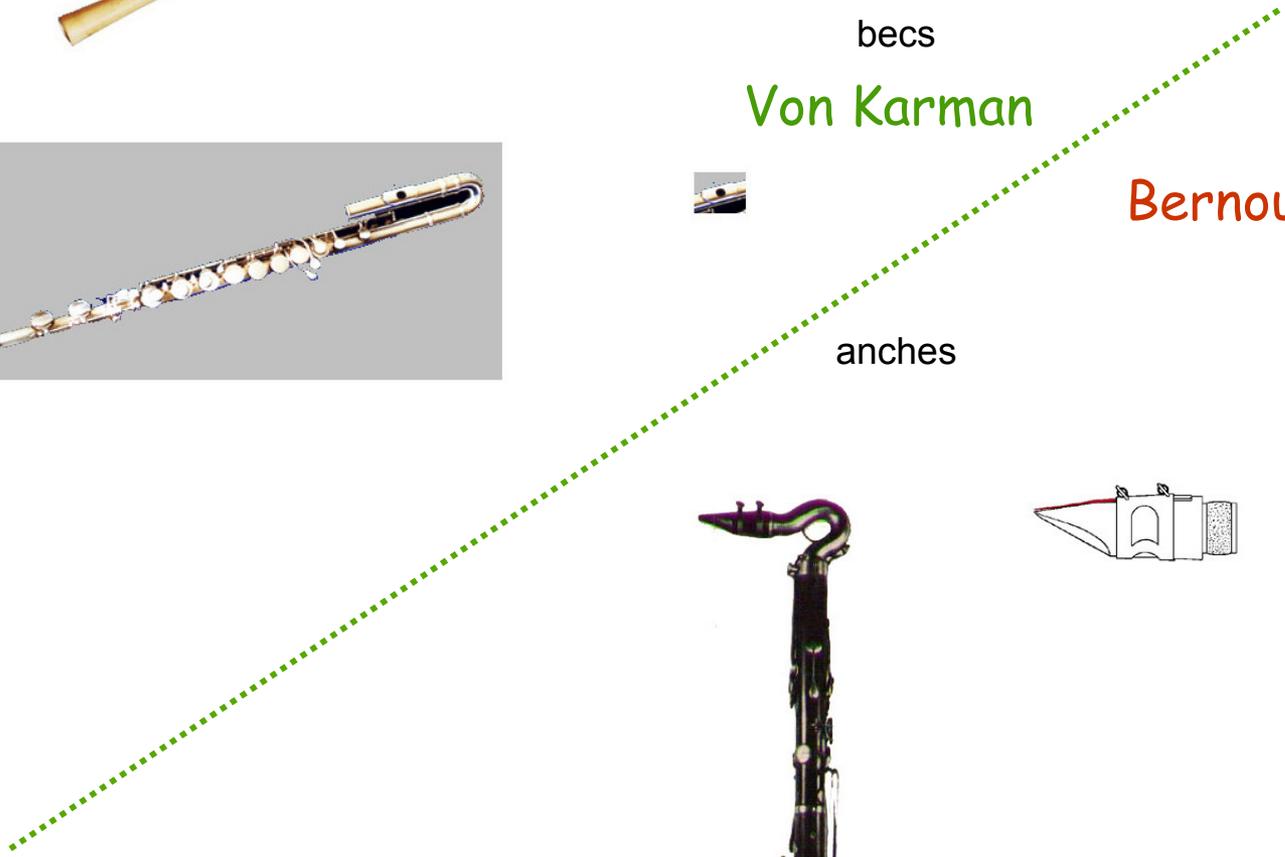
Von Karman

Bernoulli

becs

anches

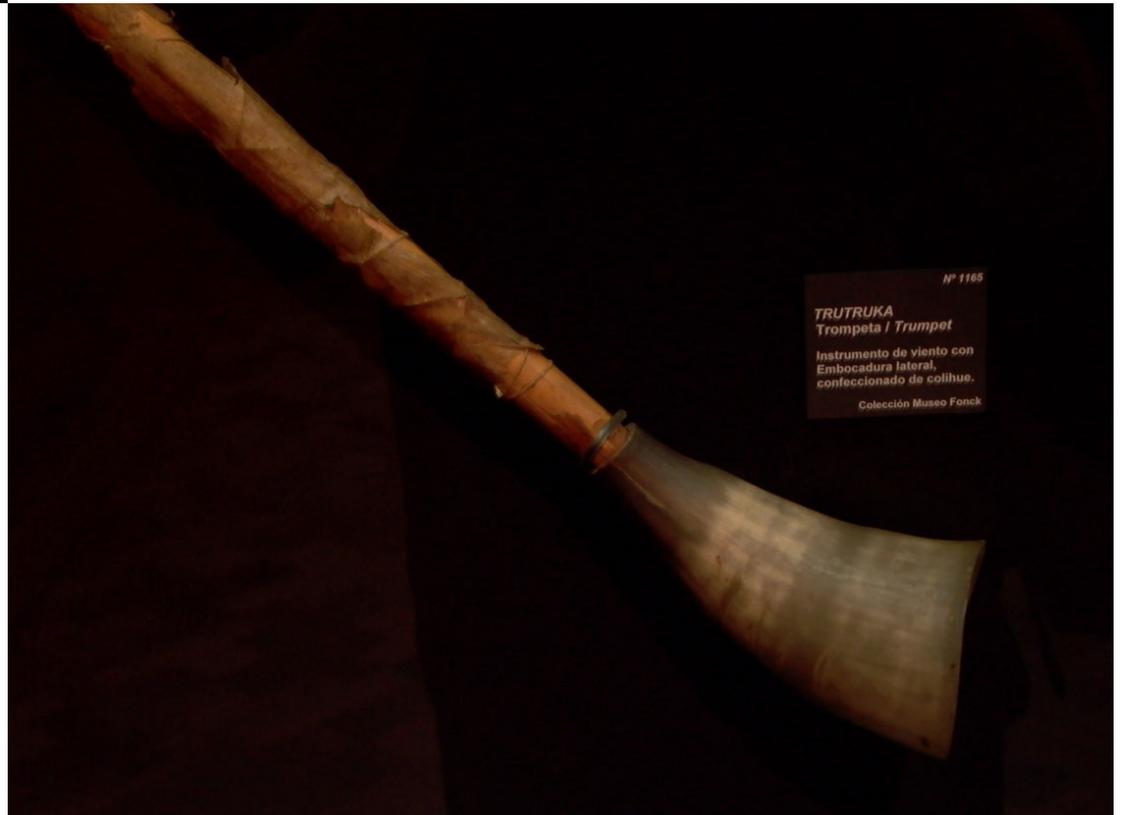
embouchures



## *Trompes Incas...*



**WILC'WILC'**  
Instrumento de viento  
de cuerno de llama  
instrumento hecho  
por los hornos de cer  
Colección Museo Fonck



**TRUTRUKA**  
Trompeta / Trumpet  
Instrumento de viento con  
Embocadura lateral,  
confeccionado de colihue.  
Colección Museo Fonck

## Pas un instrument simple ...

pas le bruit du vent ...

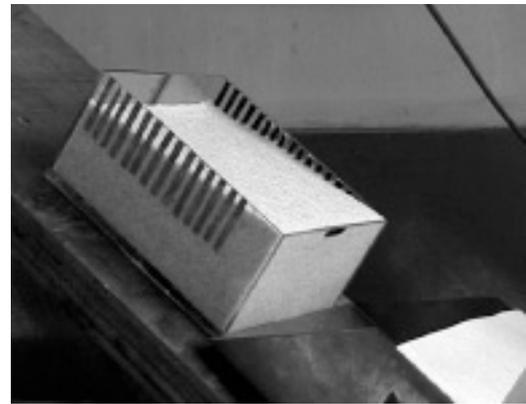
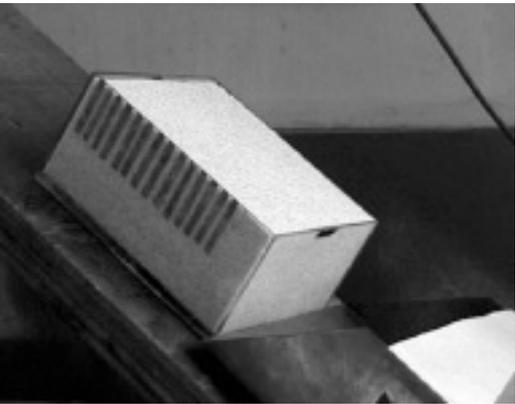
lié seulement à l'écoulement  
de l'avalanche

pas le bruit de colle-glisse ...

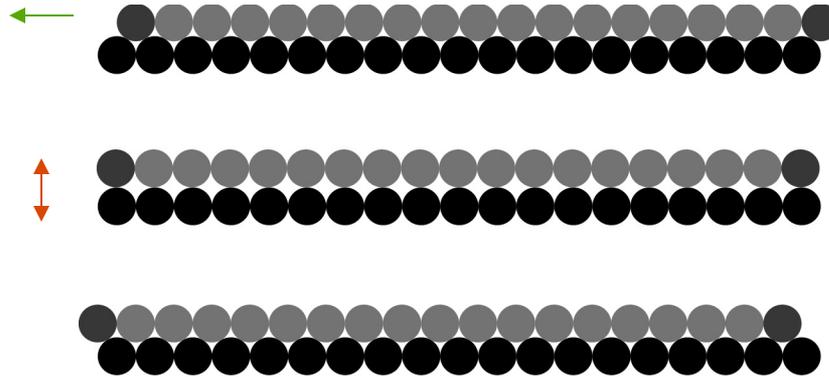
surface fluide, turbulente

pas la résonance dans la dune ...

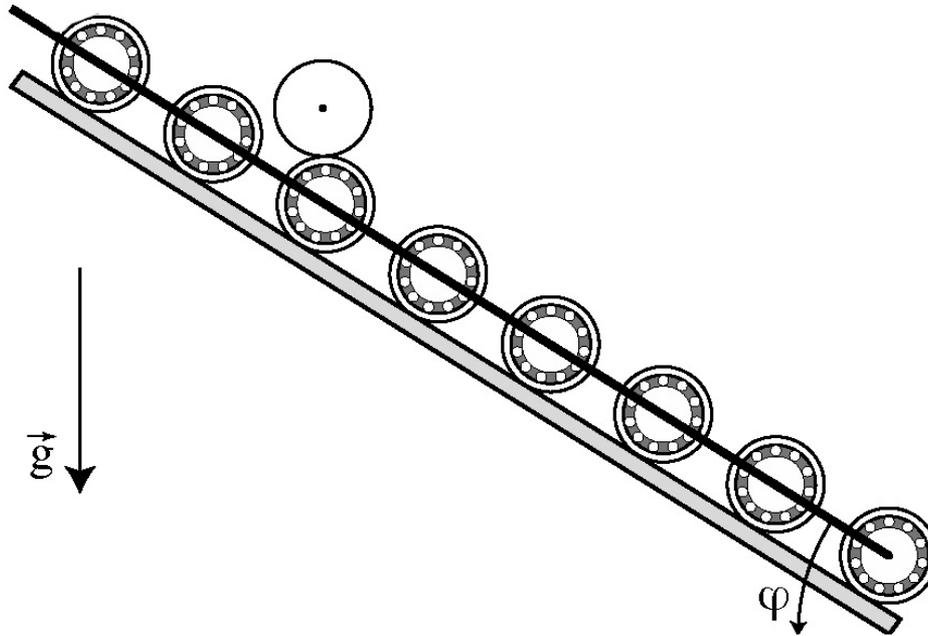
fréquence identique quelle que soit la taille de la dune  
quel que soit l'endroit dans la dune



# Reynolds Dilatancy



## Expérience du « tac-tac »

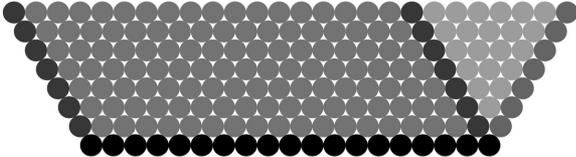


$$f = 0.4 \sqrt{\frac{g}{d}}$$

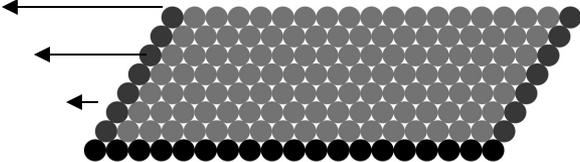
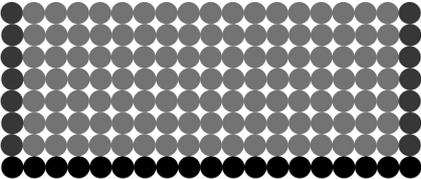
$$d = 160 \mu\text{m}$$
$$\rightarrow f = 100 \text{ Hz}$$

# Mouvement synchrone

compression



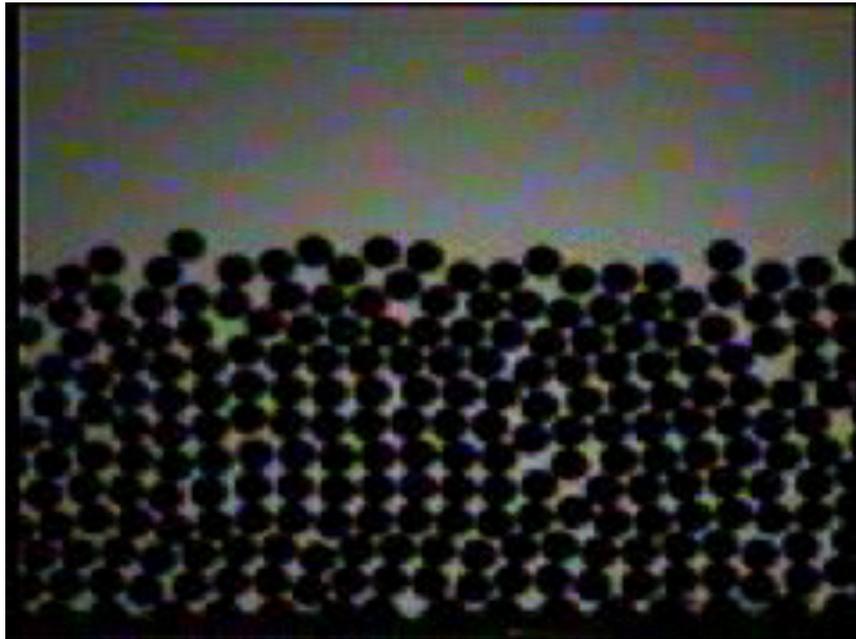
dilatation



chocs !



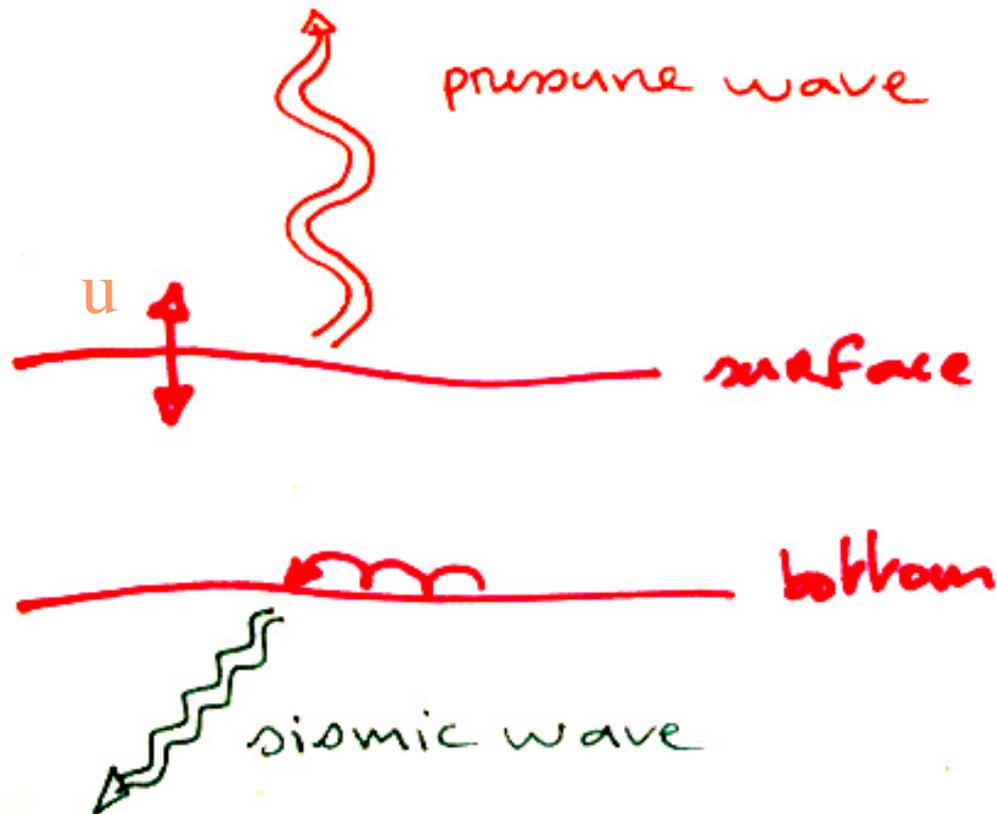
# Synchronisation expérimentale



(François Chevoir)

$$p = 1/2 \rho_{\text{air}} c u$$

(Pascal Hersen)

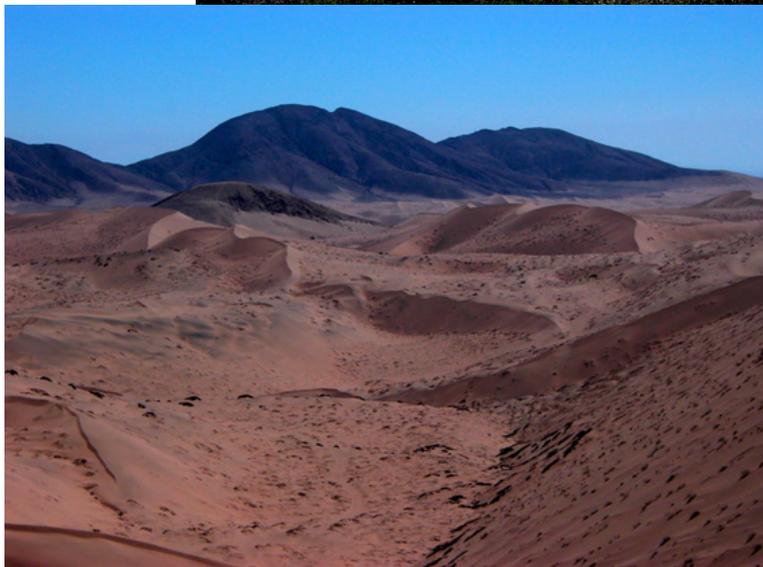




Chine



Maroc



$$f = 0.4 \sqrt{\frac{g}{d}}$$

?

Chili



## ¡ Cerro Bramador !

Near Copiapo, Chile  
(Atacama Desert)

*(first quotation by Darwin)*

*Recording thanks to  
Audrey Manning!*

¡ 65 to 80 Hz !

In the Lab...

versement



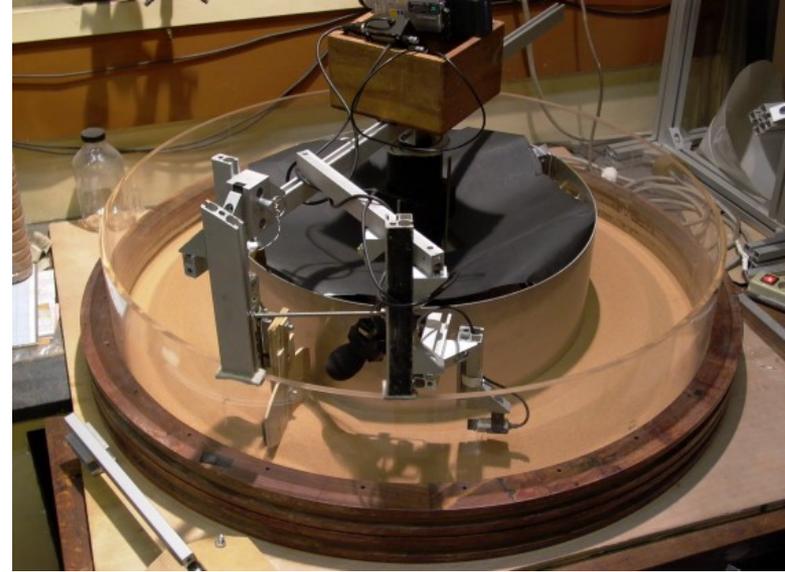
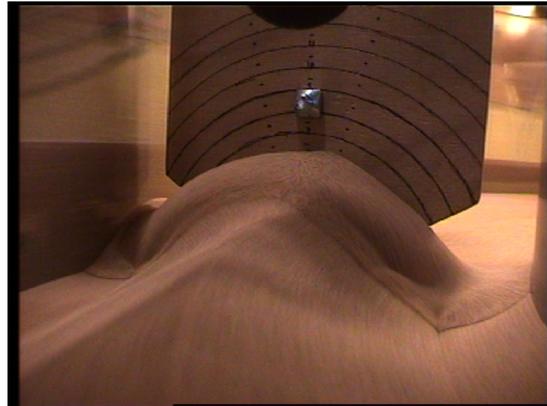


chocs

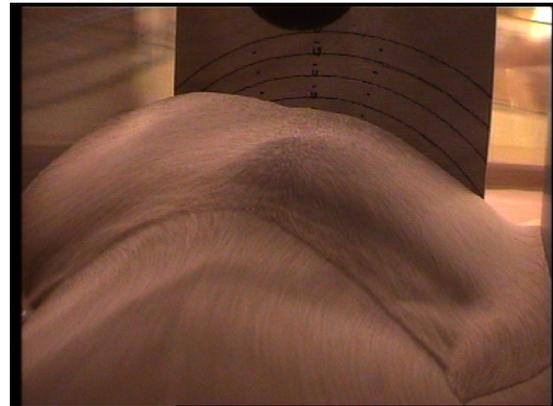


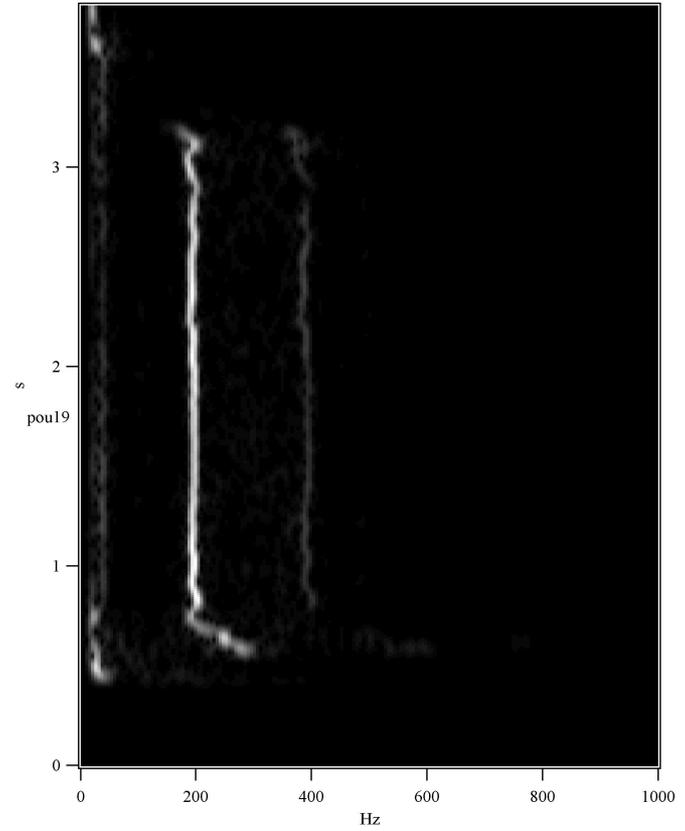


(Chilean 'music' )



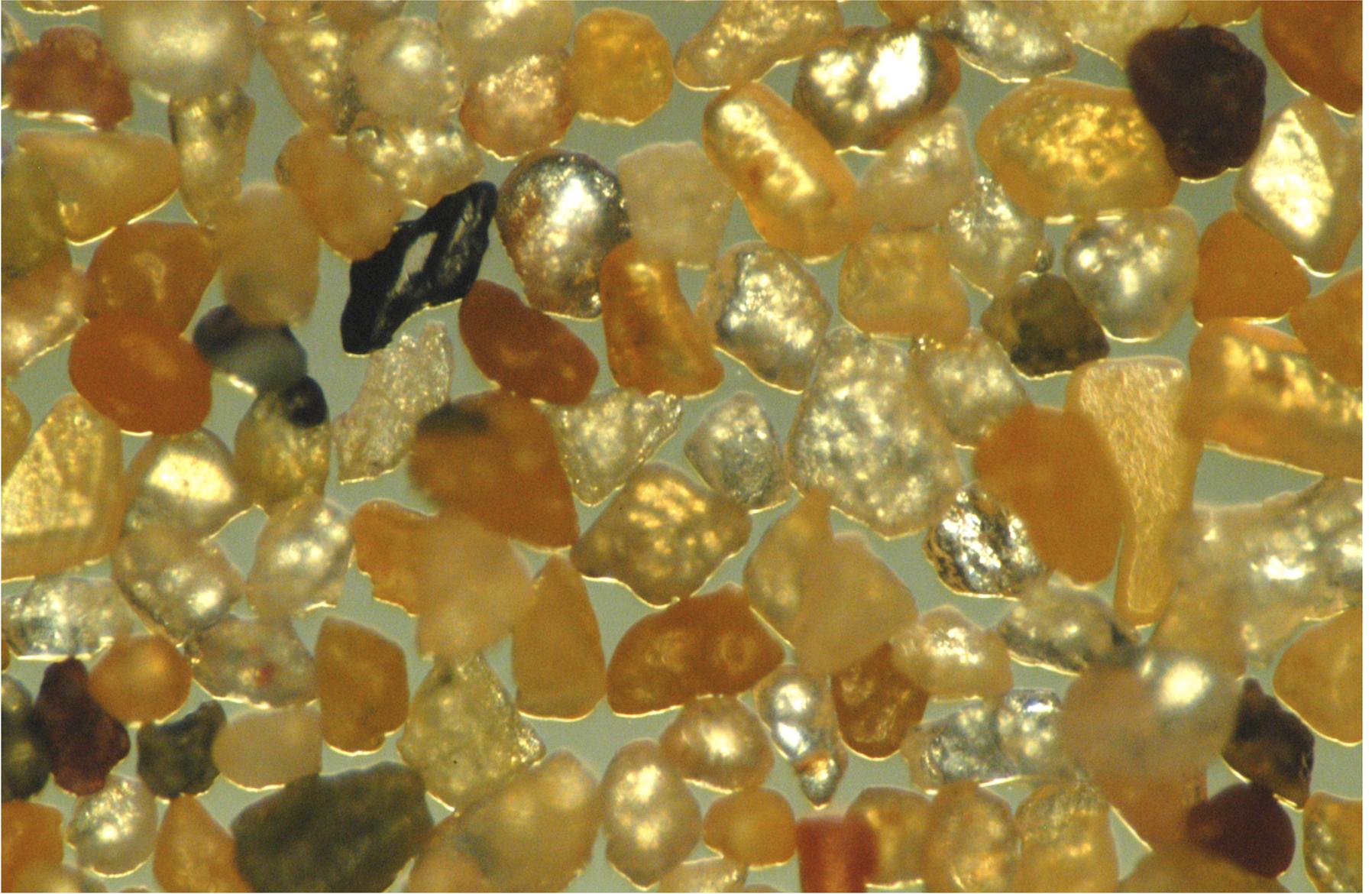
Contrôle indépendant de la **masse** et de la **vitesse**





Gamme descendante & remontée (montage)

# Sable Musical



Grains « frais »

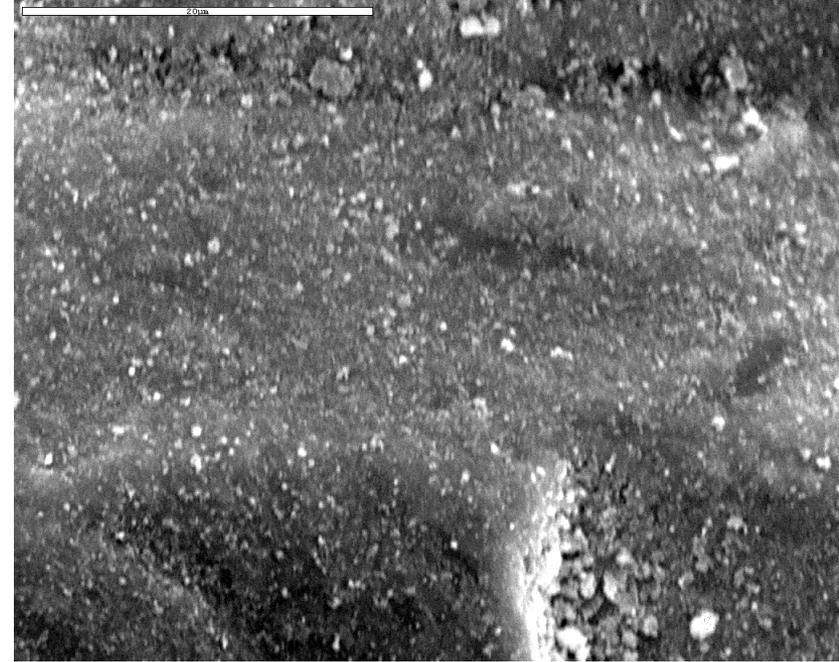
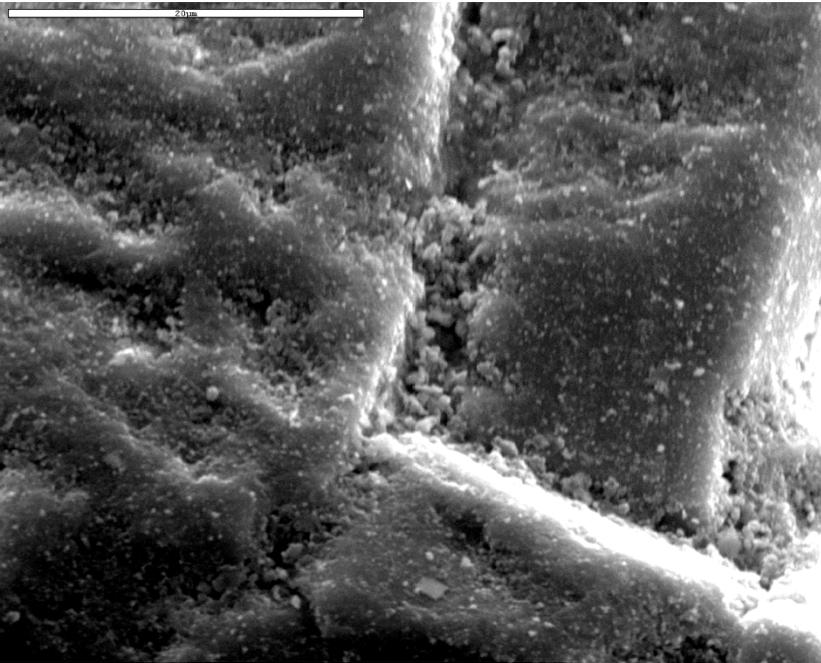
mais il s'use ... !

« what have these grains special? » Audrey Manning

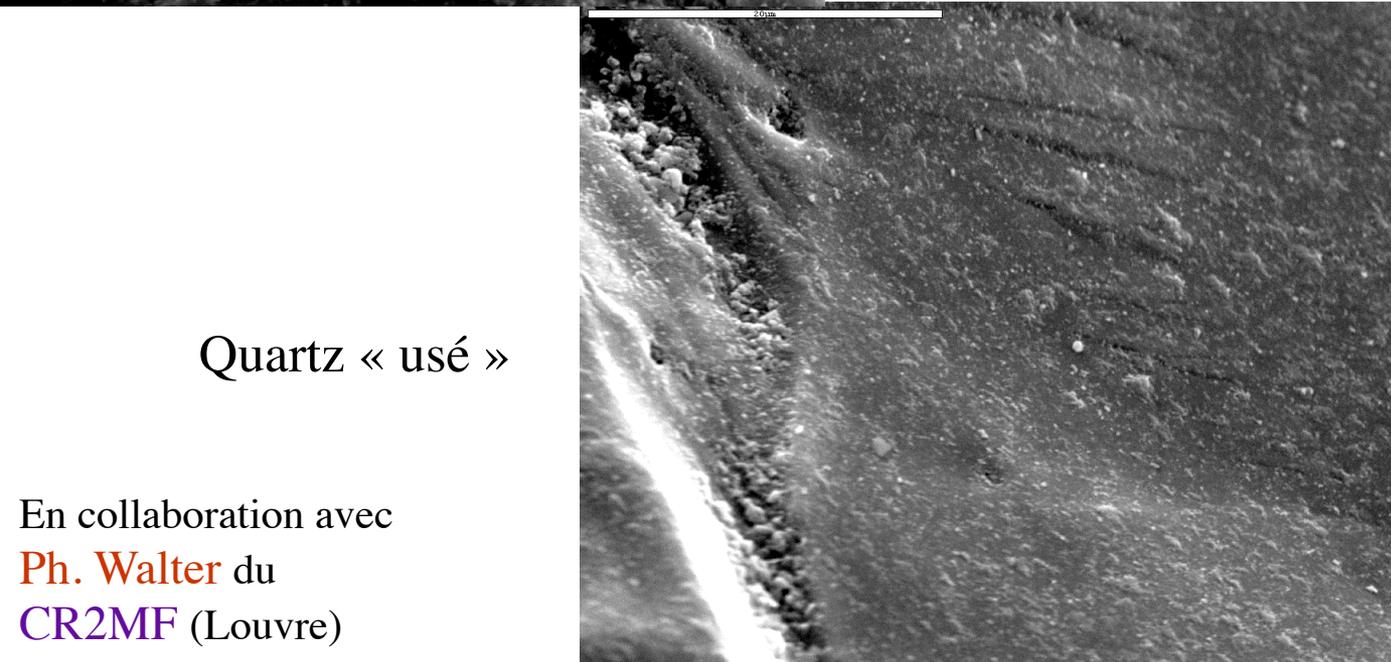


Grains « usés »

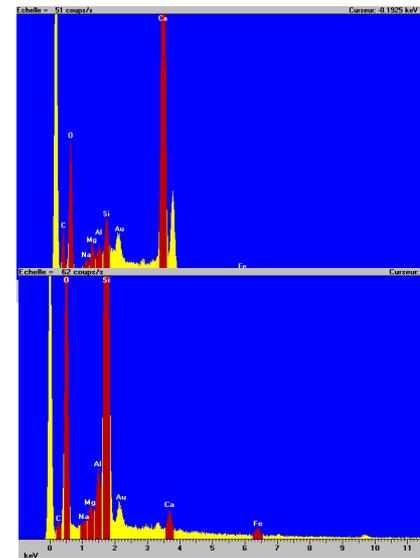
# Quartz « frais »



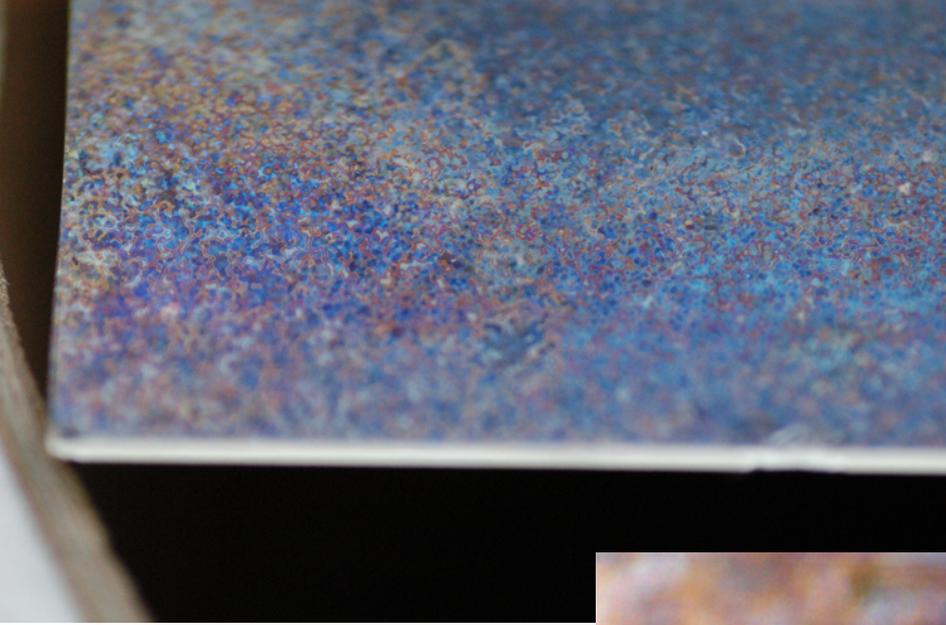
# Quartz « restauré »



# Quartz « utilisé »

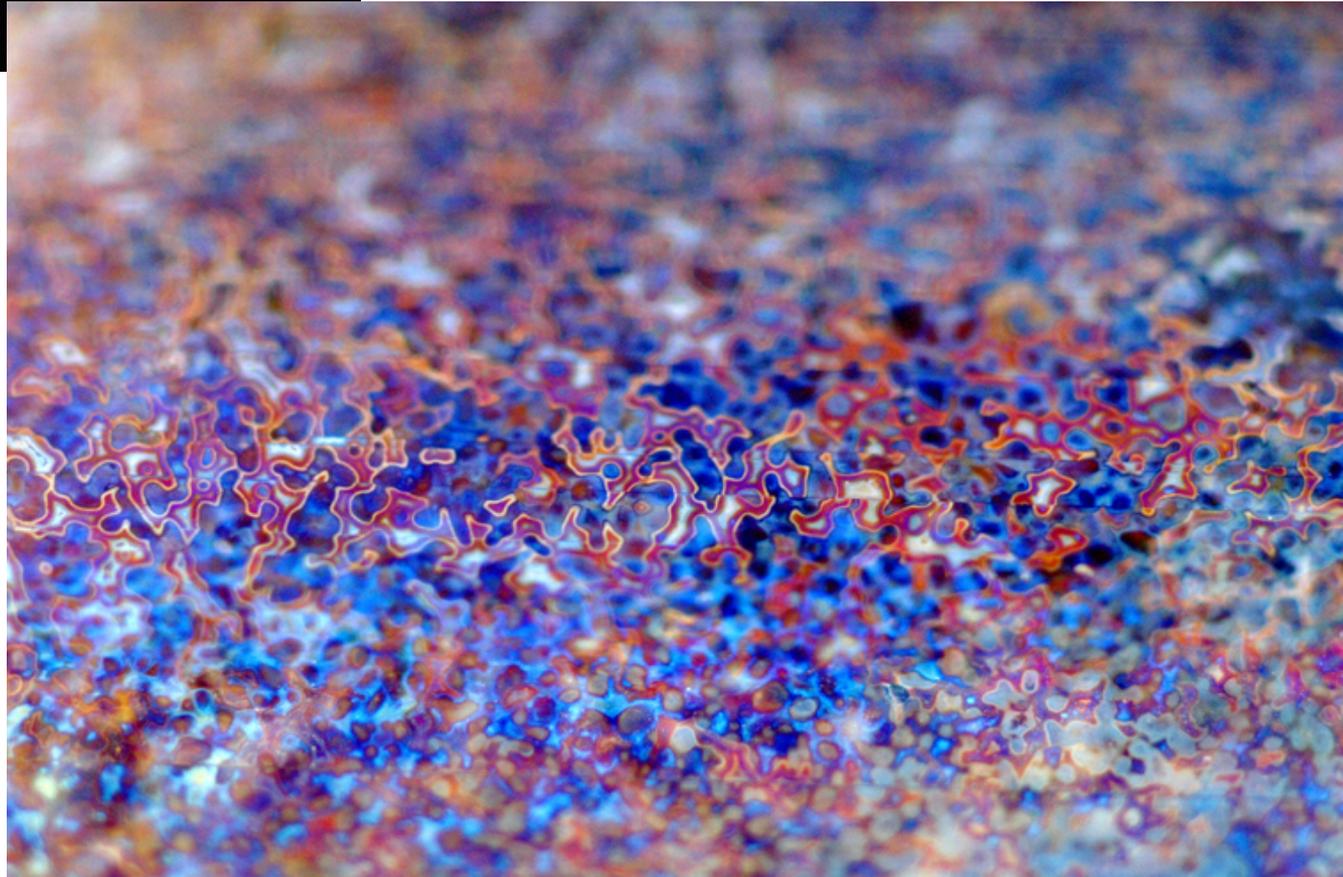


En collaboration avec  
**Ph. Walter** du  
**CR2MF** (Louvre)



Grains « restaurés »

Plaque témoin



## Recette :

Prendre des grains *ronds*

(sable de plage à grands rouleaux, i.e. sud des Landes ou des billes de verre)

Rajouter des grains *frais à composition variée*

(granite, métamorphique, ... )

Si possible réduites en poudre (pas nécessaire)

Mouiller d'*eau salée* saturée, *sécher au four* doux,

Remouiller, resécher

(avec plaques de verre témoins du dépôt)

Bien *rincer et sécher* (plusieurs fois)

# Conclusion :

*« With an eye made quiet by the power of harmony,  
and the deep power of joy, we see into the life of things. »*

*(William Wordsworth)*

**« Avec un œil rendu serein par la puissance de l'harmonie,  
et le profond pouvoir de la joie, la vie des choses nous apparaît ... »**