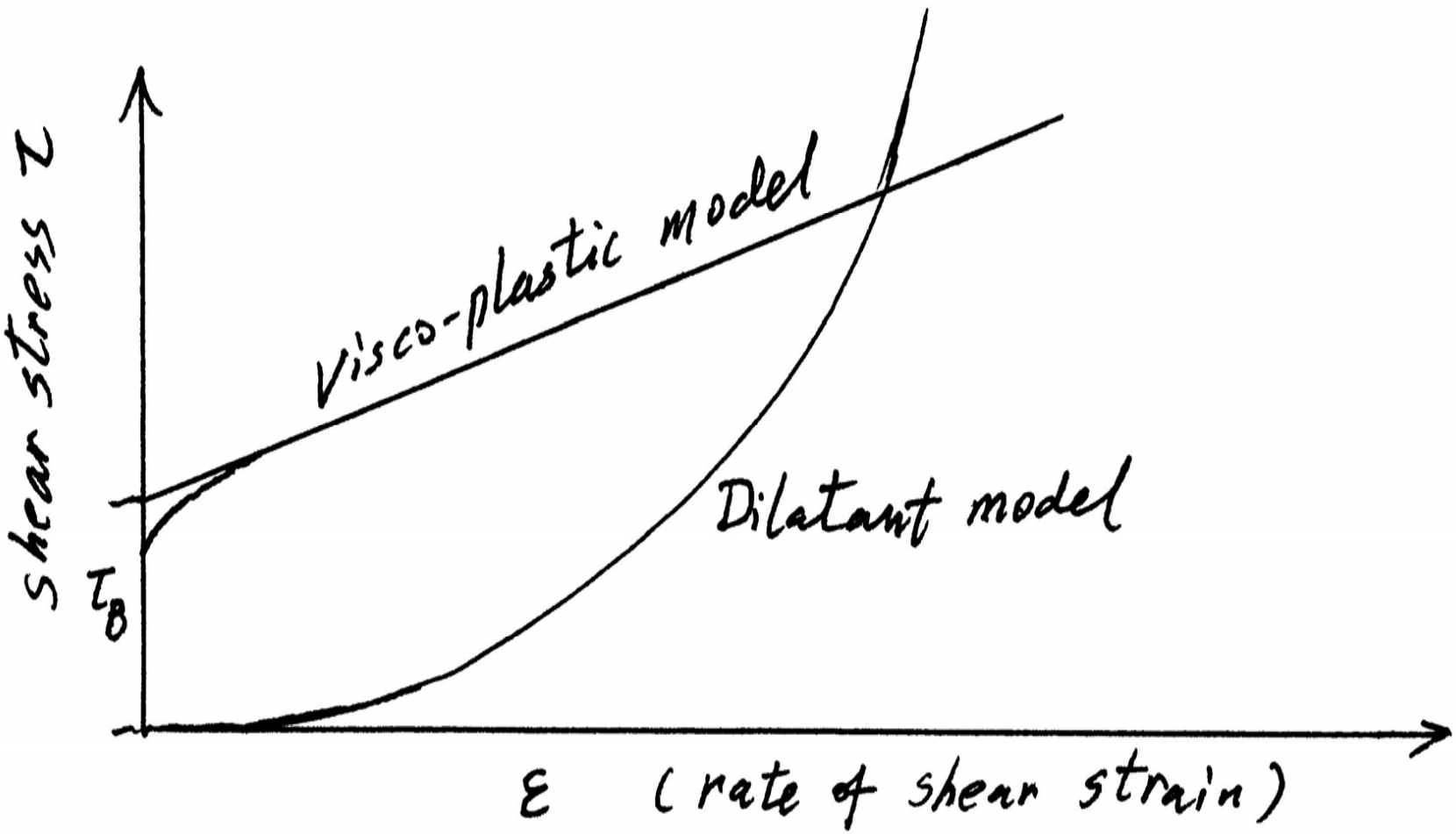
2. PHENOMENA AND MECHANISMS OF DEBRIS FLOWS

Two phase debris flow and viscous debris flow

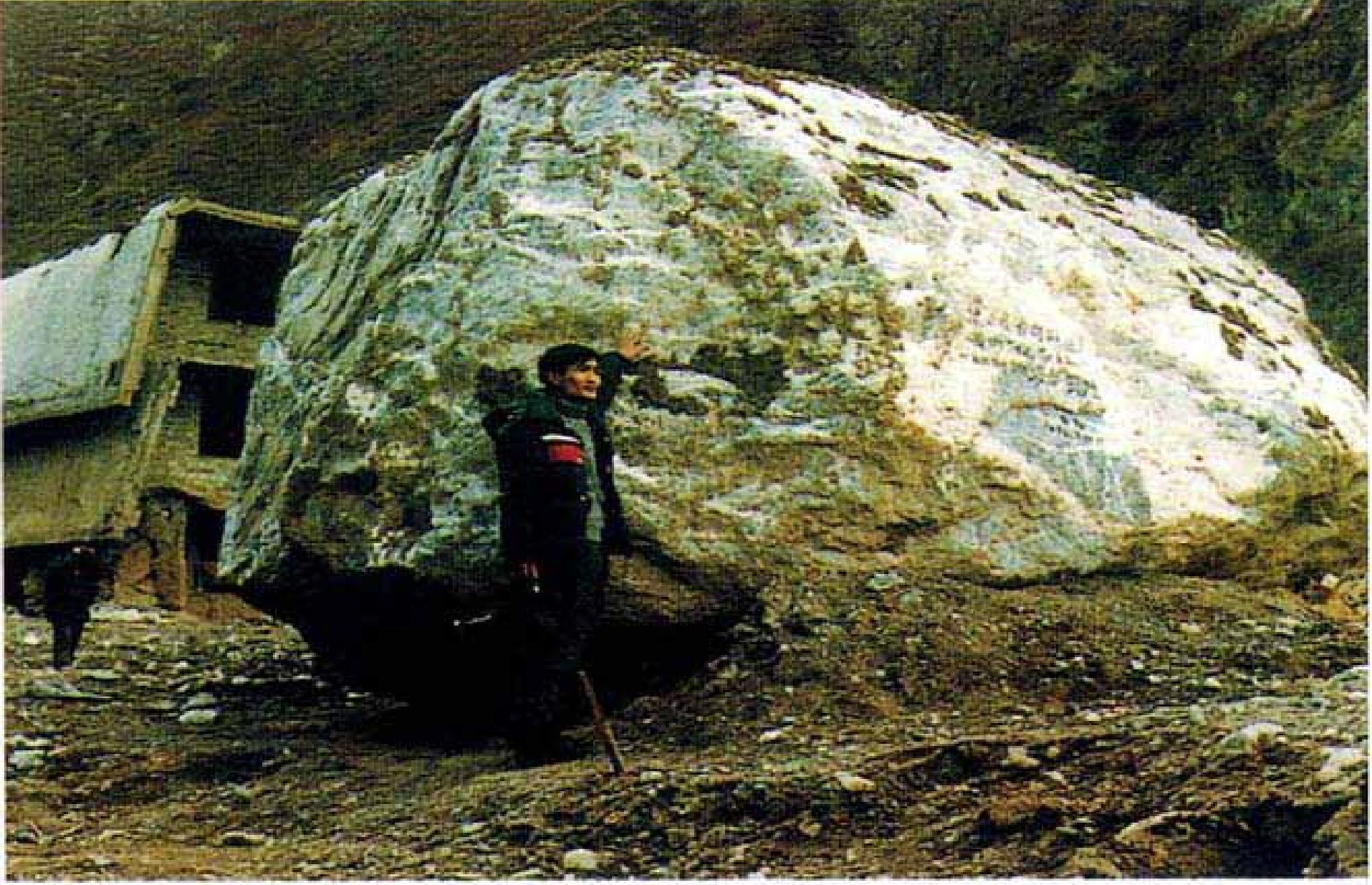

粘性紊流
Viscous turbulent flow

Debris flow deposit 边上淤积粘泥中砾石呈中凸状纵坡约10%


shear stress τ
Visco-plastic model
Dilatant model
τ_B
ε (rate of shear strain)

王兆印泥石流遇险纪实The deposit is still fluid

Unsorted debris flow deposit 泥石流沉积物粗细颗粒不分选



Strong Sediment Transport Capacity and Destructive Power

TWO-PHASE DEBRIS FLOWS

Initiation of Debris flow

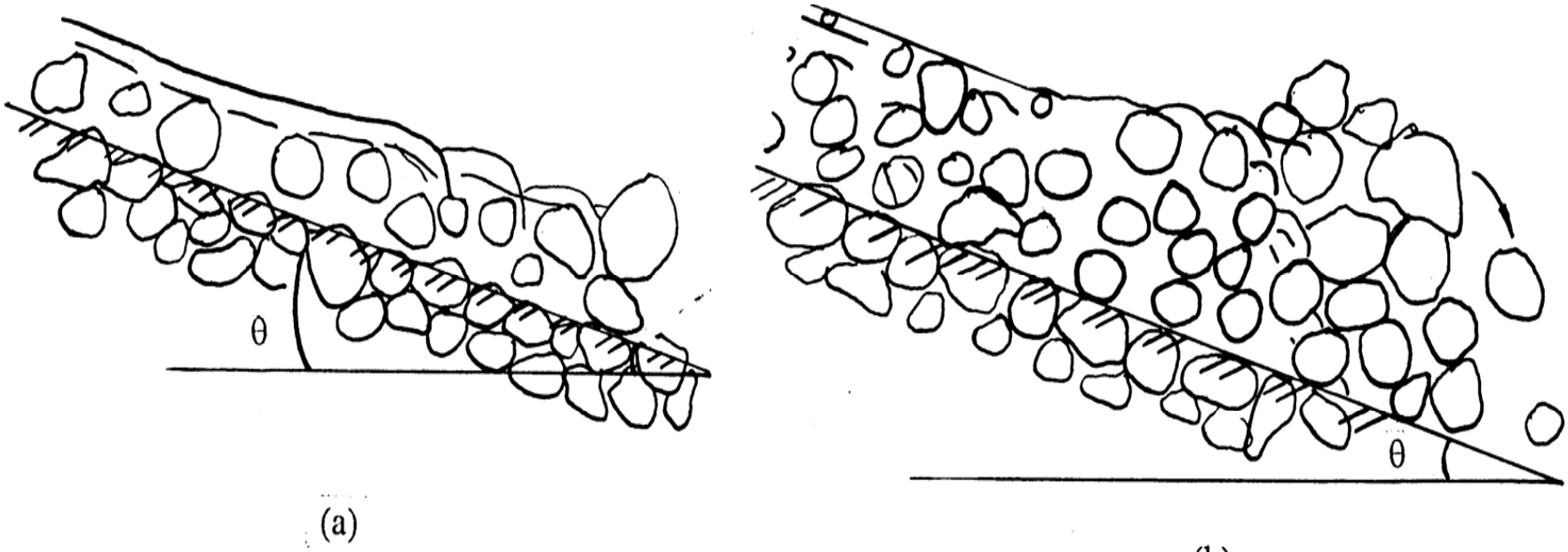


Fig. 2-30a Development and initiation of Debris flow from experiments

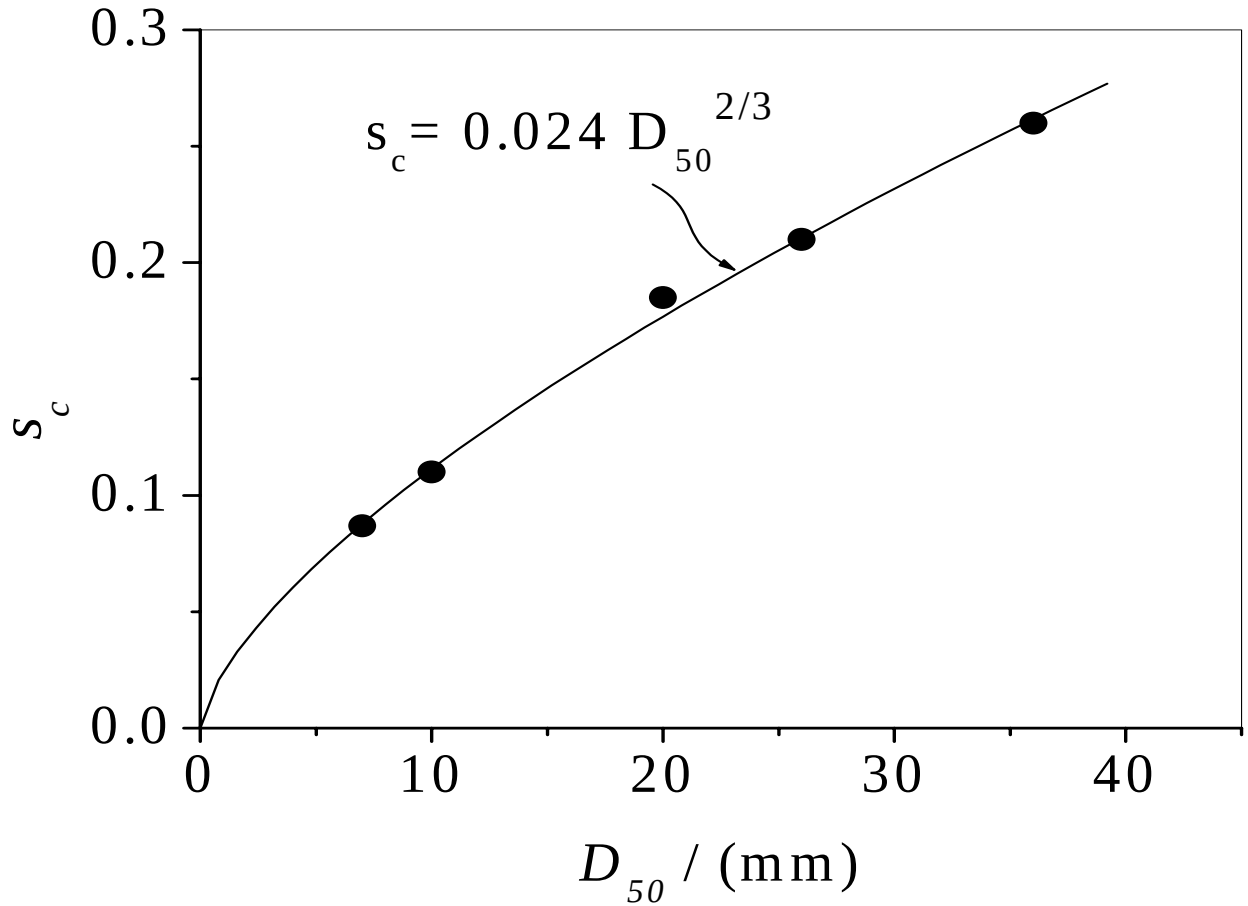


Fig. 3.18 Critical slope for initiation of debris flow as a function of the median diameter of bed material.

The height of the head is proportional to the particles size

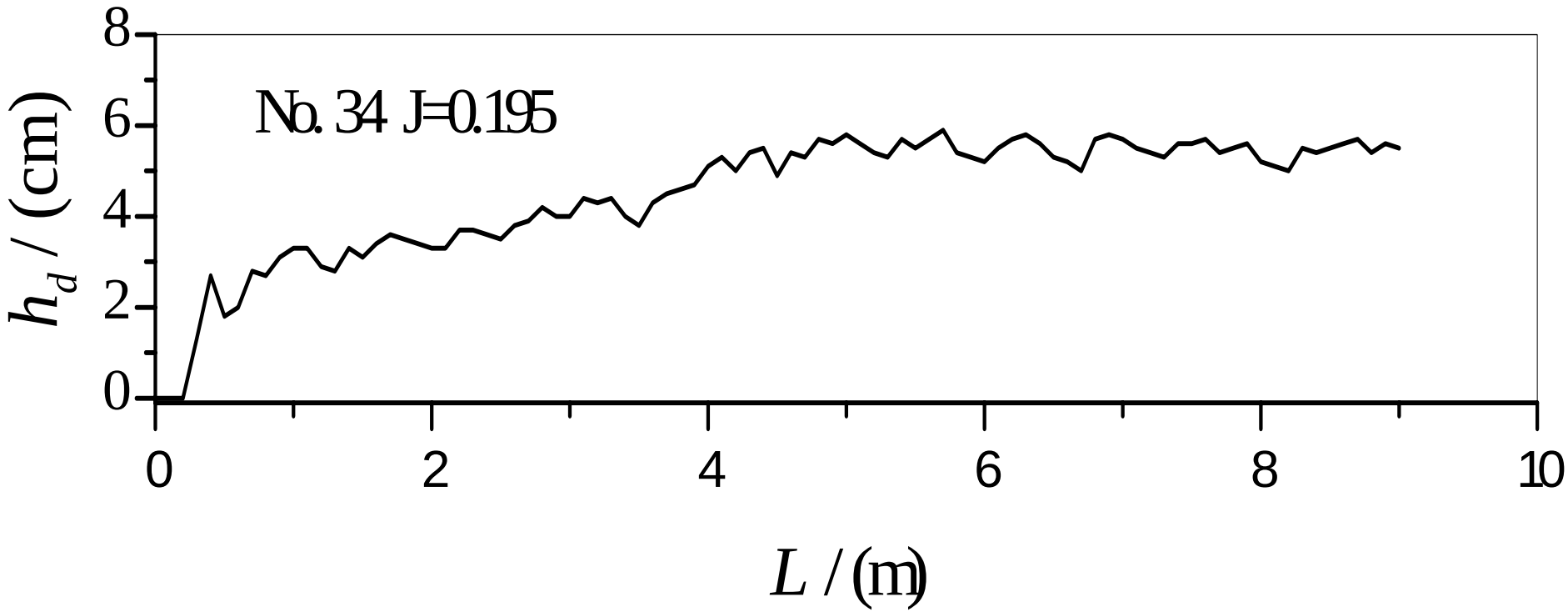
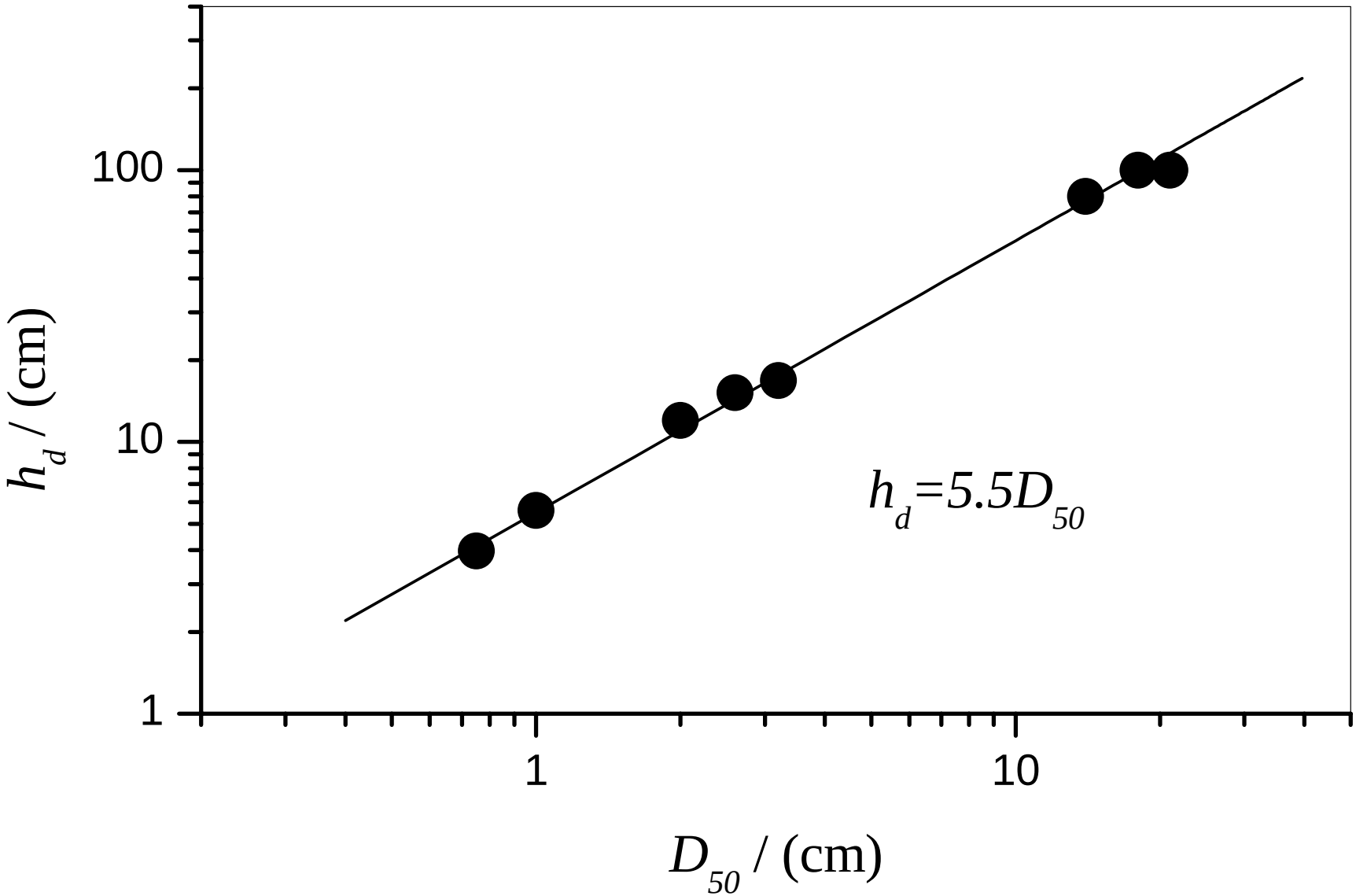
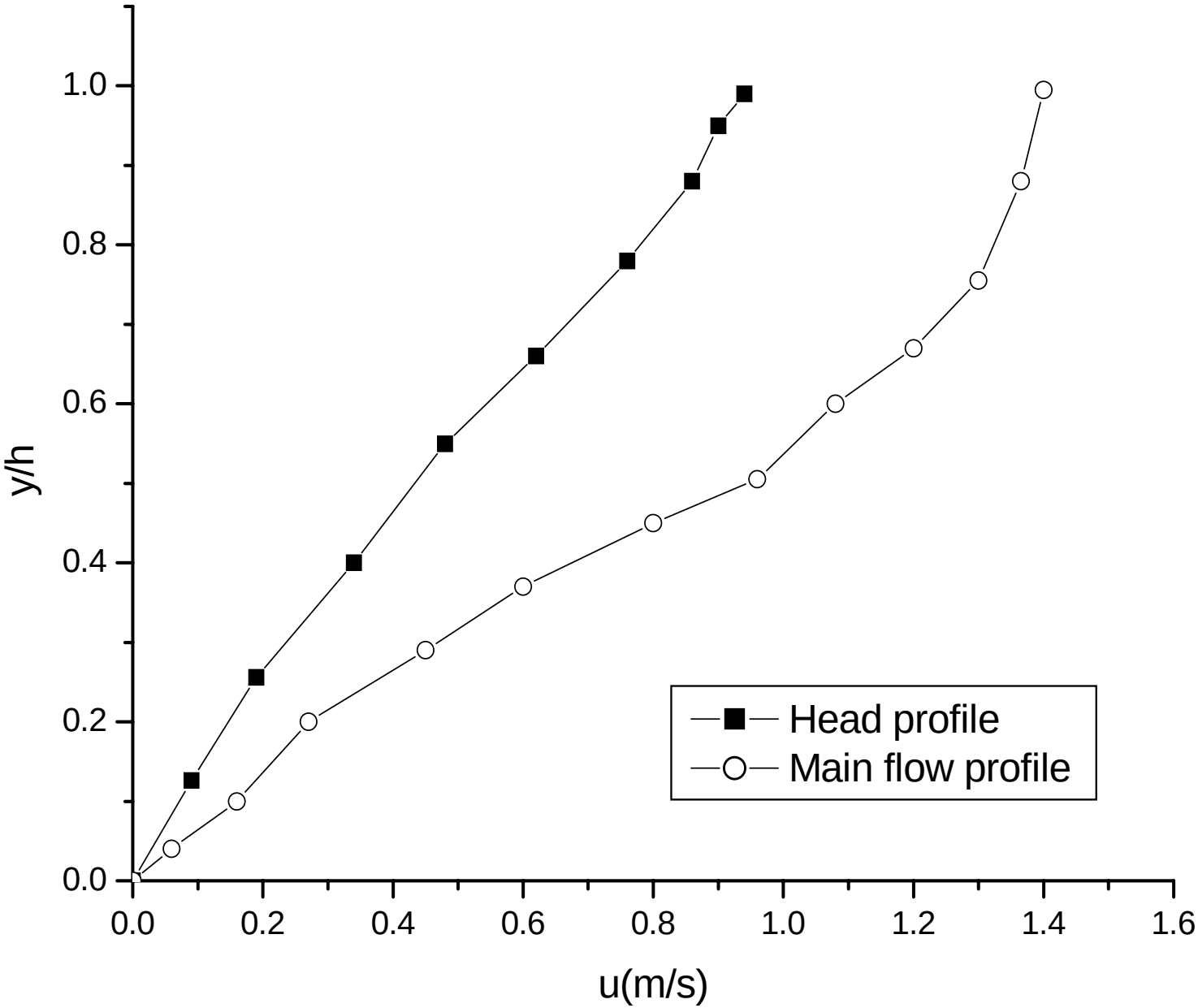
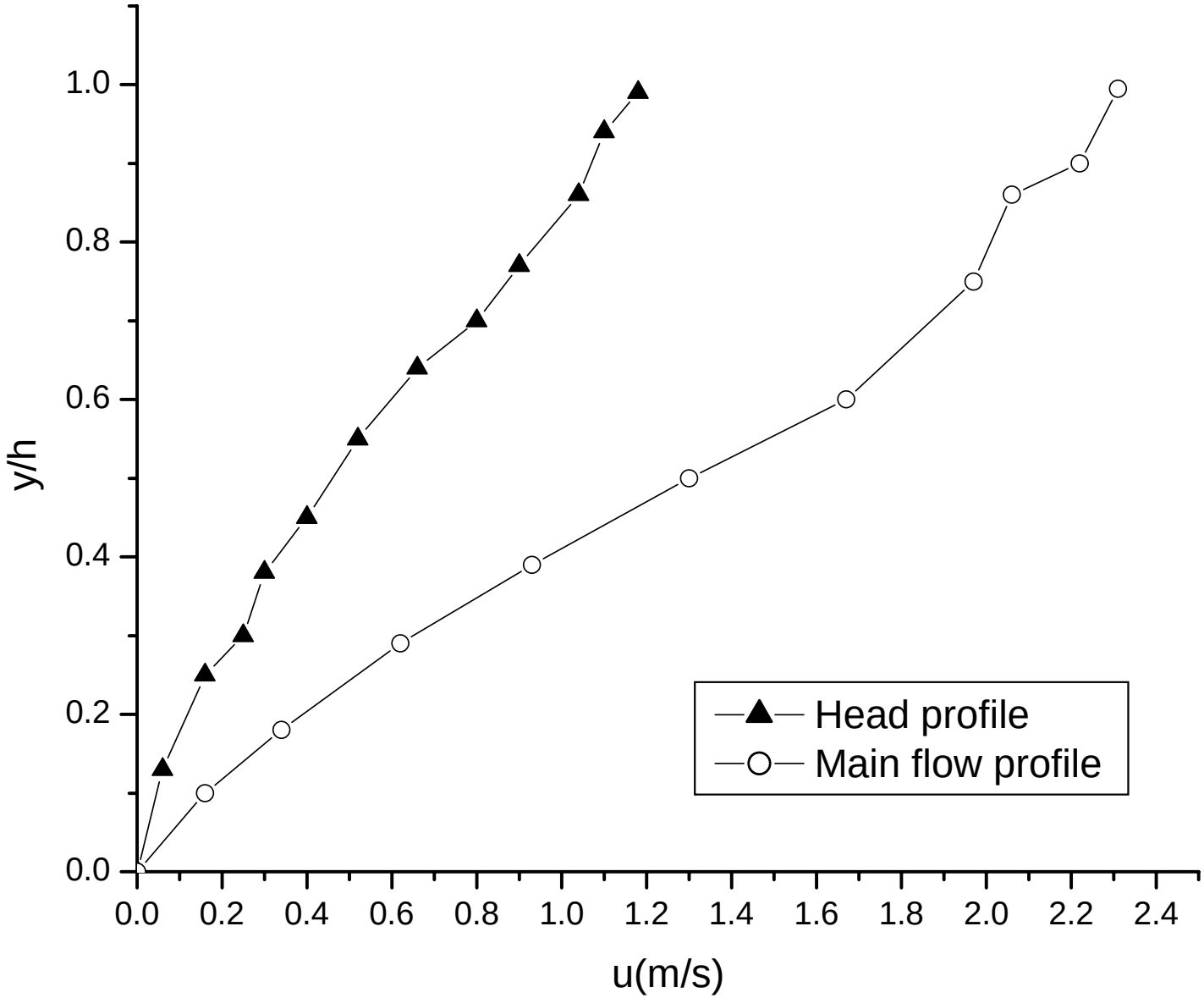


Fig. 3.19 Growth process of the debris flow head (L = the distance from the entrance, h_d = the height of the debris flow head)

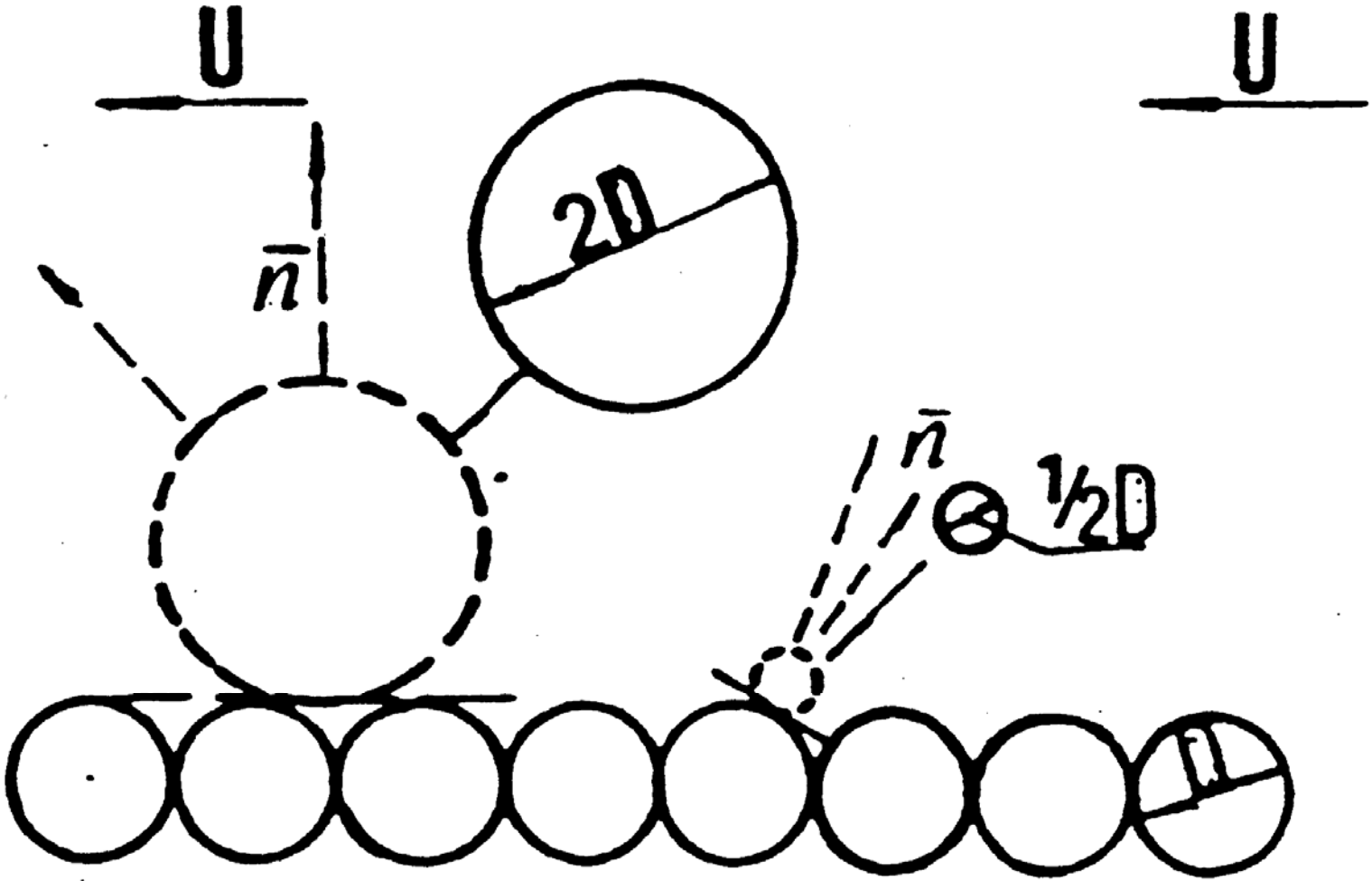

100
10
1
1
10
h_d / (cm)
D_{50} / (cm)
$h_d=5.5D_{50}$

Velocity profiles of solid particles in two-phase debris flows

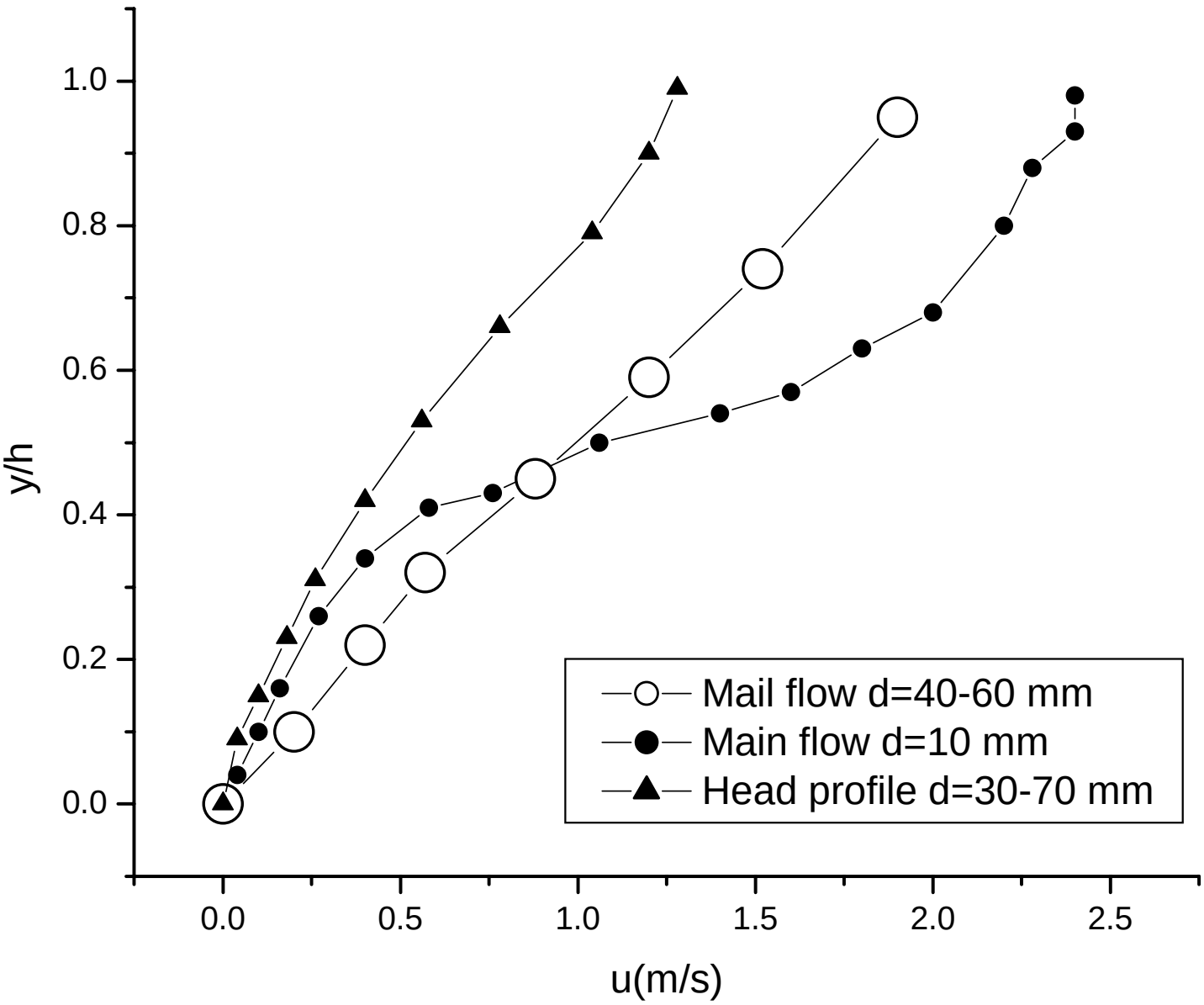

y/h
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
u(m/s)
Head profile
Main flow profile


y/h
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
u(m/s)
Head profile
Main flow profile

Large particles move faster and concentrate in the head



A sketch resistances of larger and smaller particles owing to collision with bed particles


y/h
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
2.5
u(m/s)
Mail flow d=40-60 mm
Main flow d=10 mm
Head profile d=30-70 mm

Mechanism of viscous debris flow

Development of Roll waves

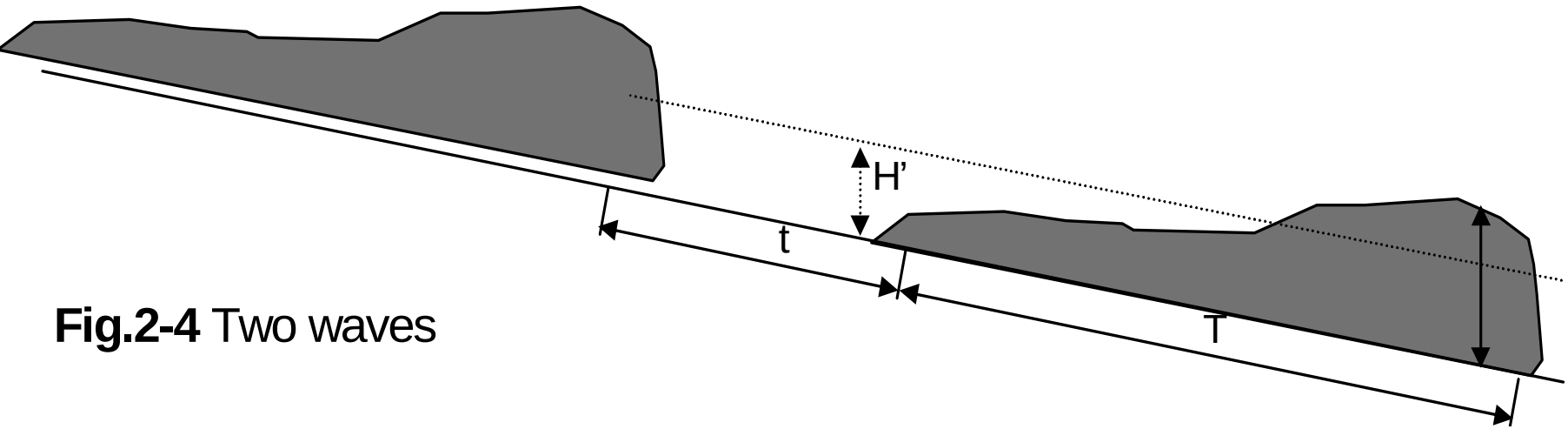


Fig.2-4 Two waves

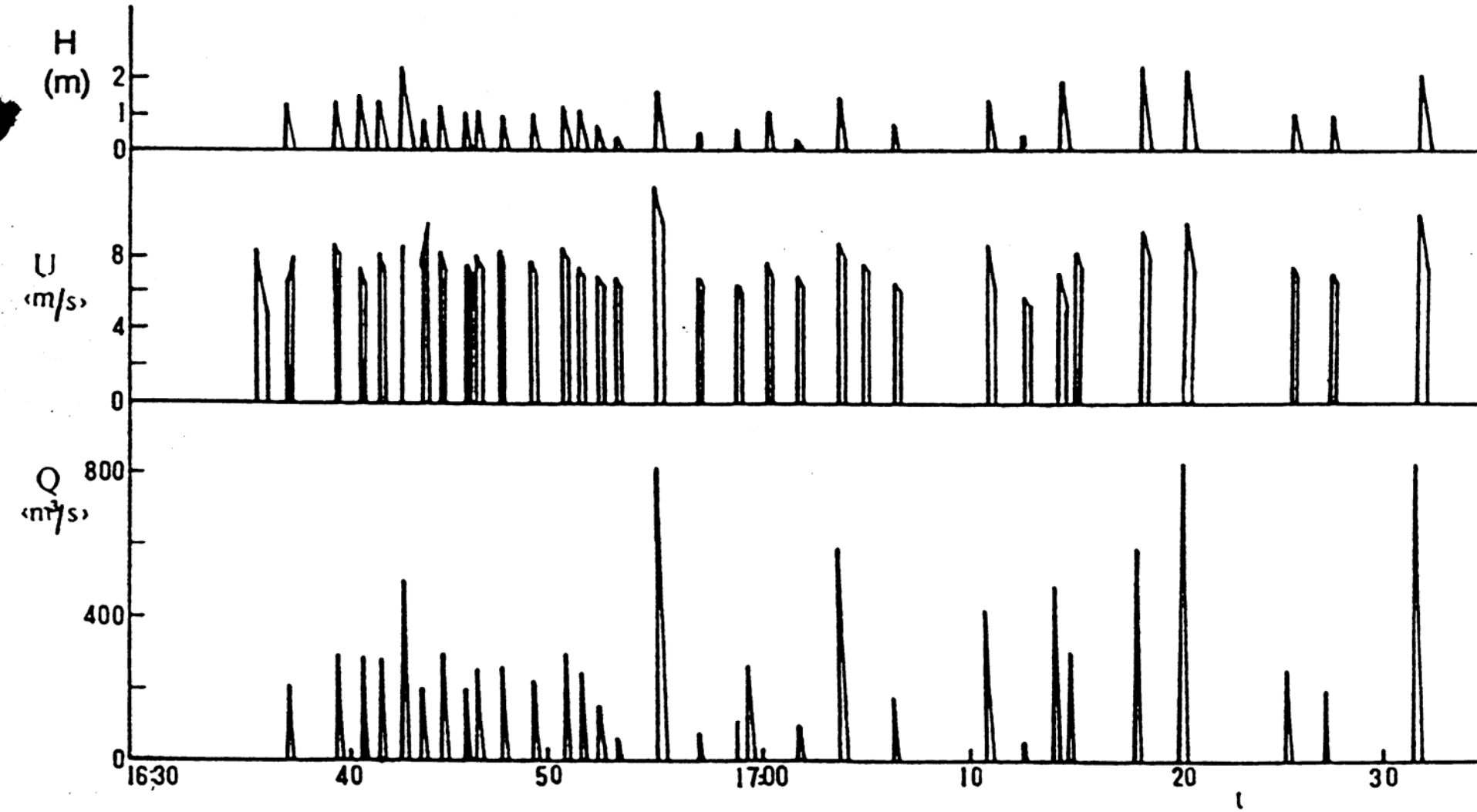
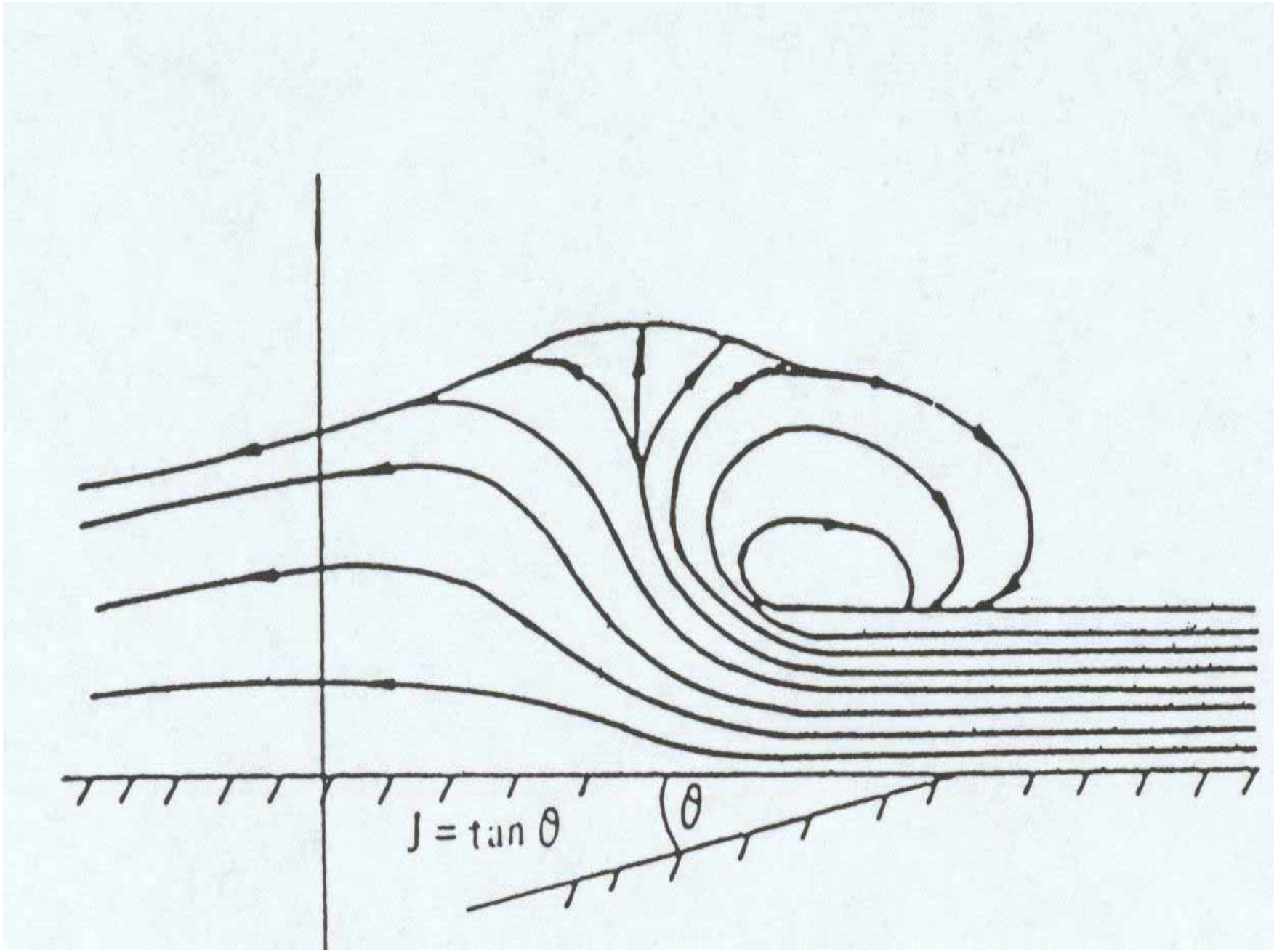
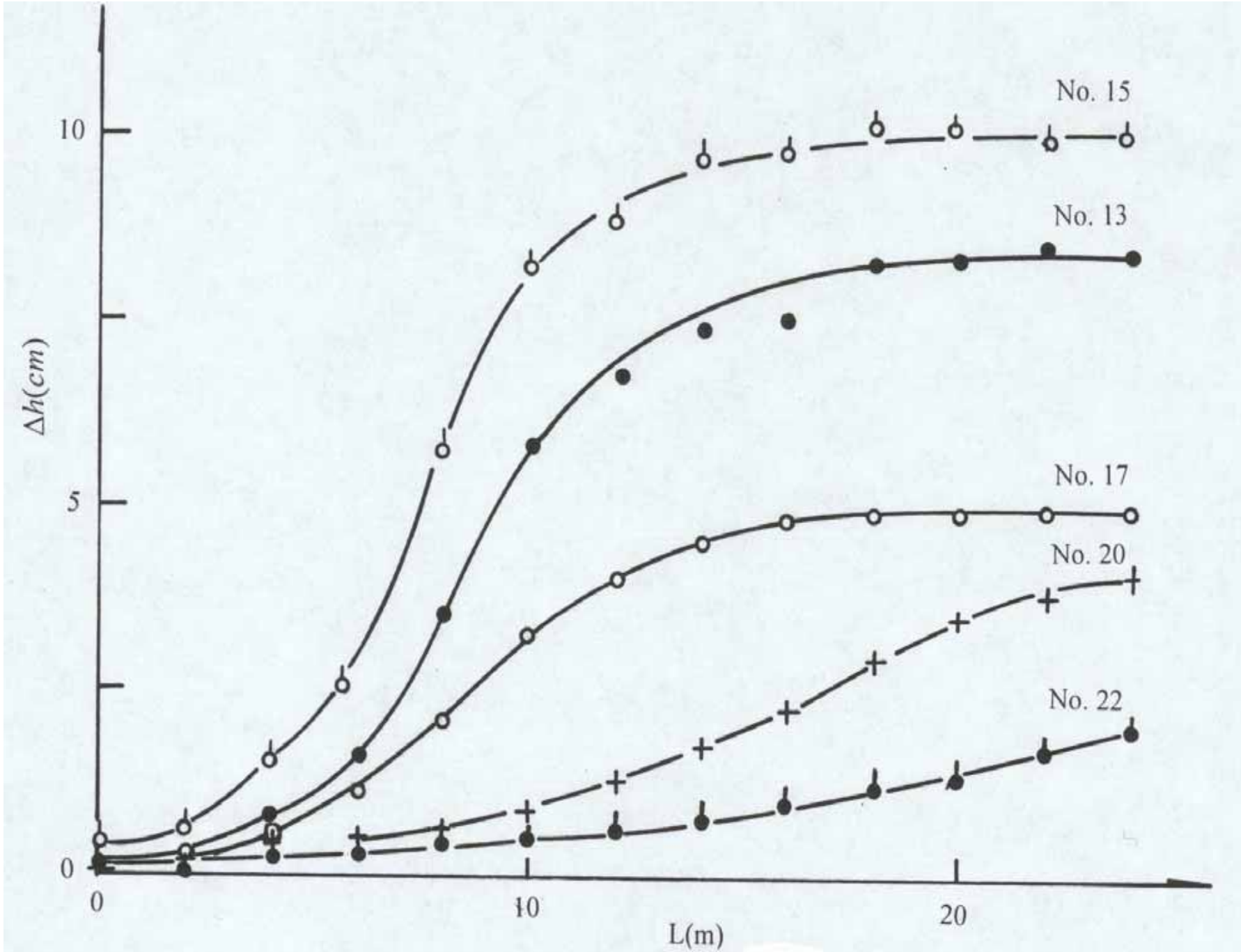
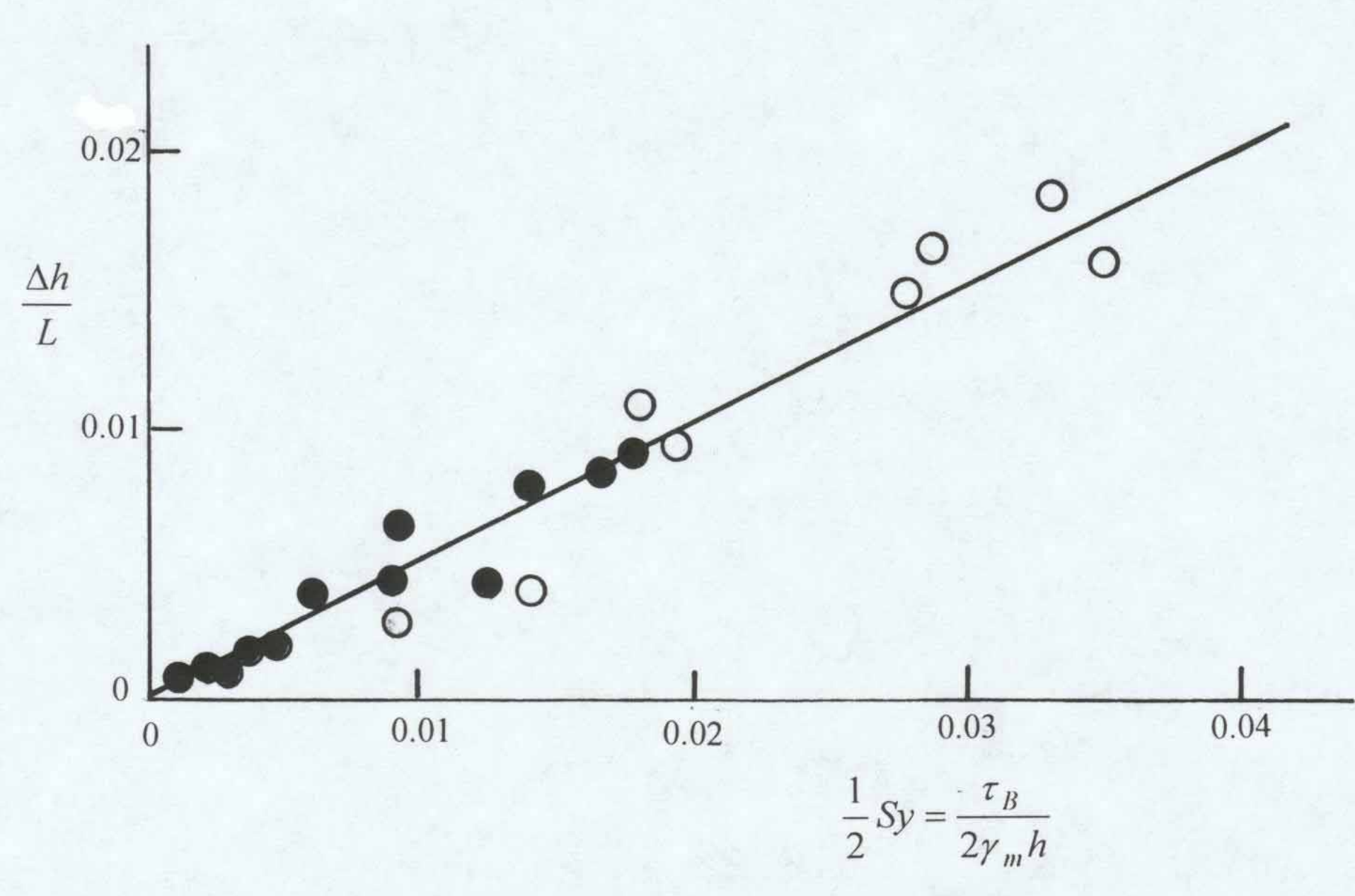


Figure 2-2 . A typical process of debris flow waves in the Jiangjia Gully.


J = tan θ
θ

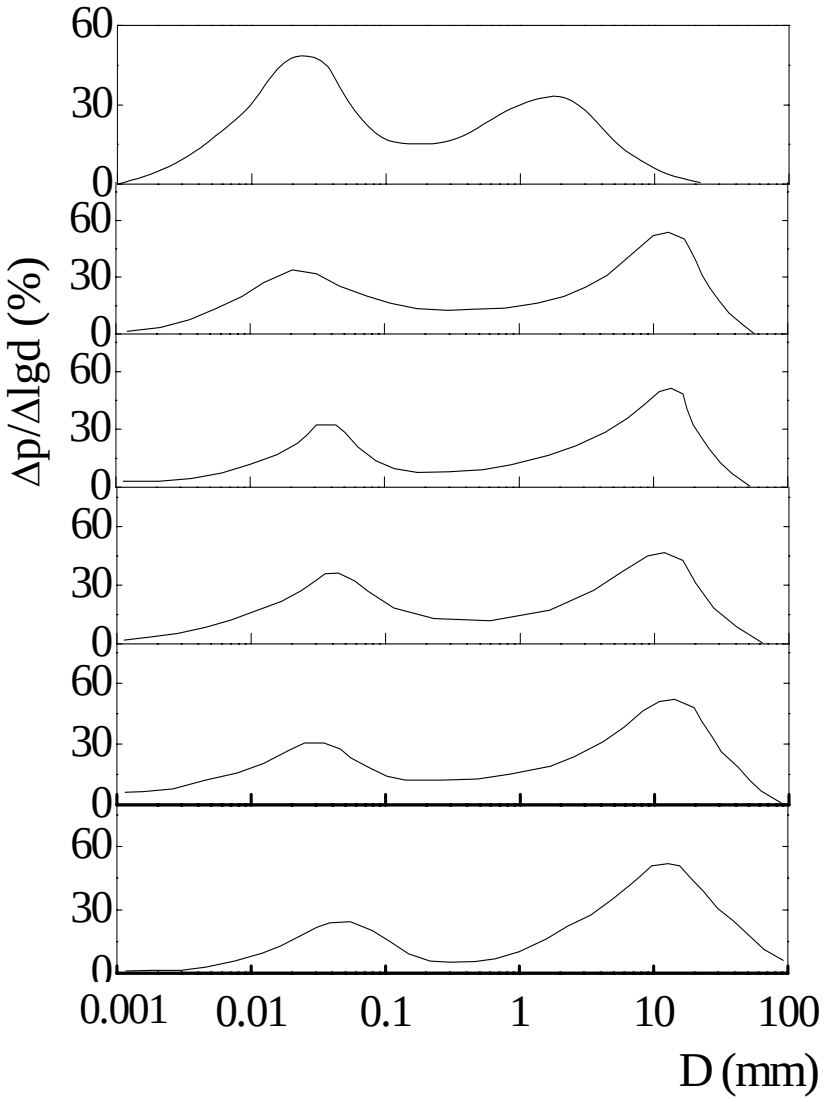

No. 15
No. 13
No. 17
No. 20
No. 22
10
5
0
Δh(cm)
0
10
20
L(m)

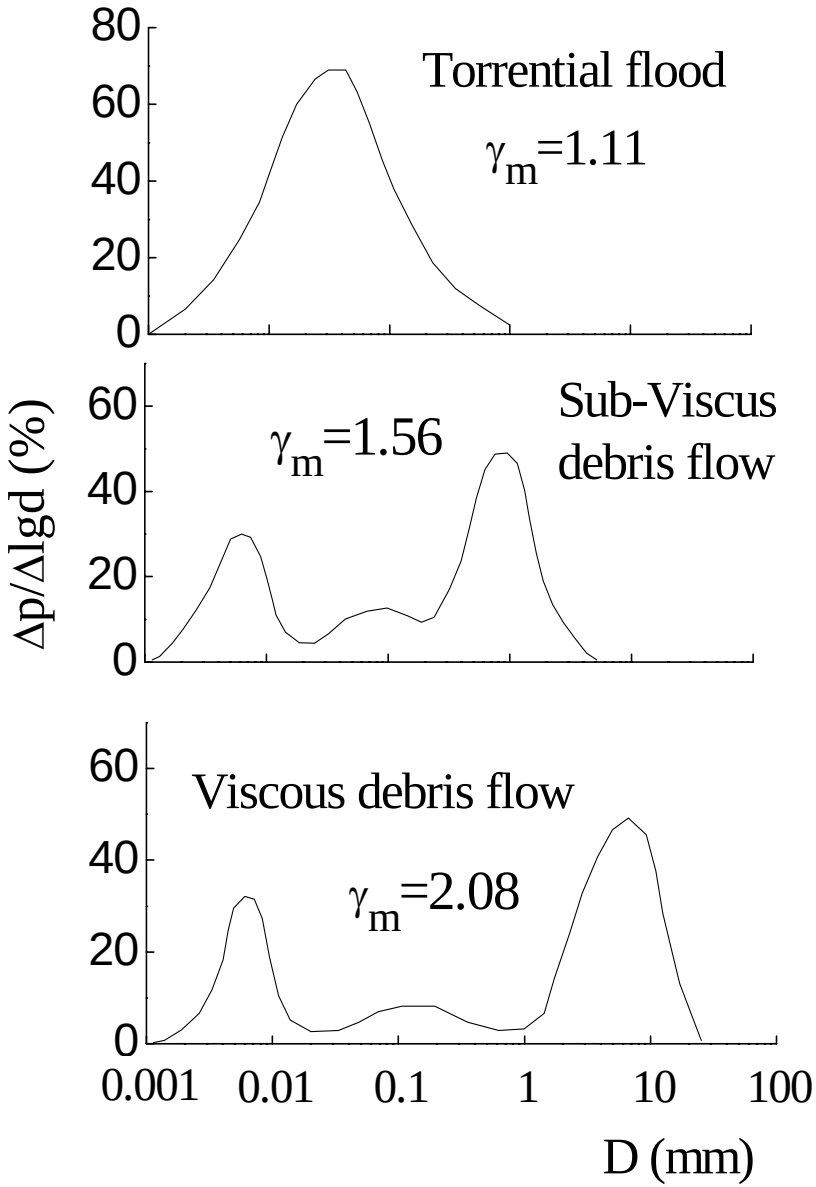

0.02
0.01
0
$\frac{\Delta h}{L}$
0
0.01
0.02
0.03
0.04
$\frac{1}{2} Sy = \frac{\tau_B}{2\gamma_m h}$

Roll waves and bed-paving process


粘性紊流
Viscous turbulent flow

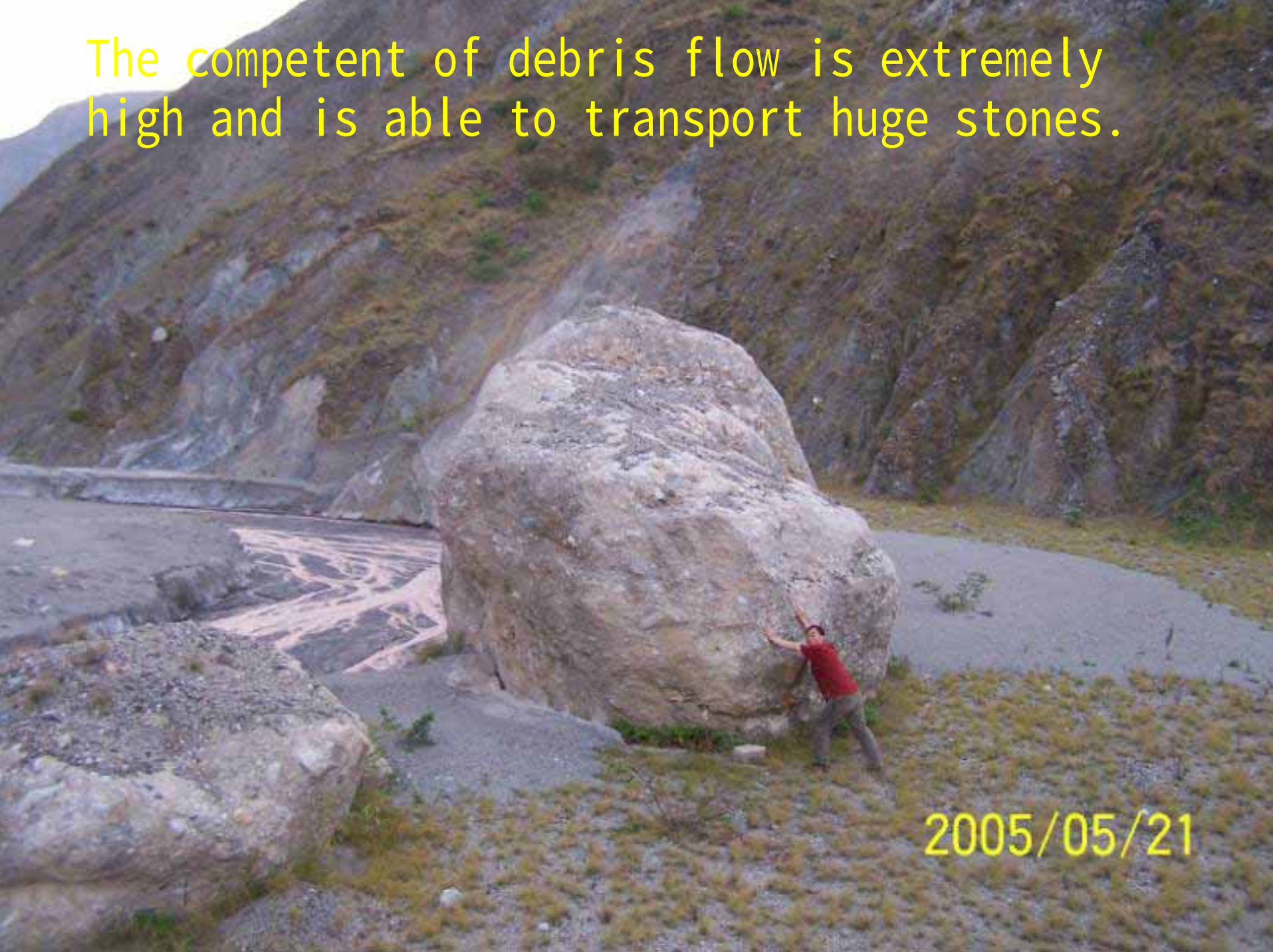
Extremely high superelevation at bends and climbing over ascend slopes





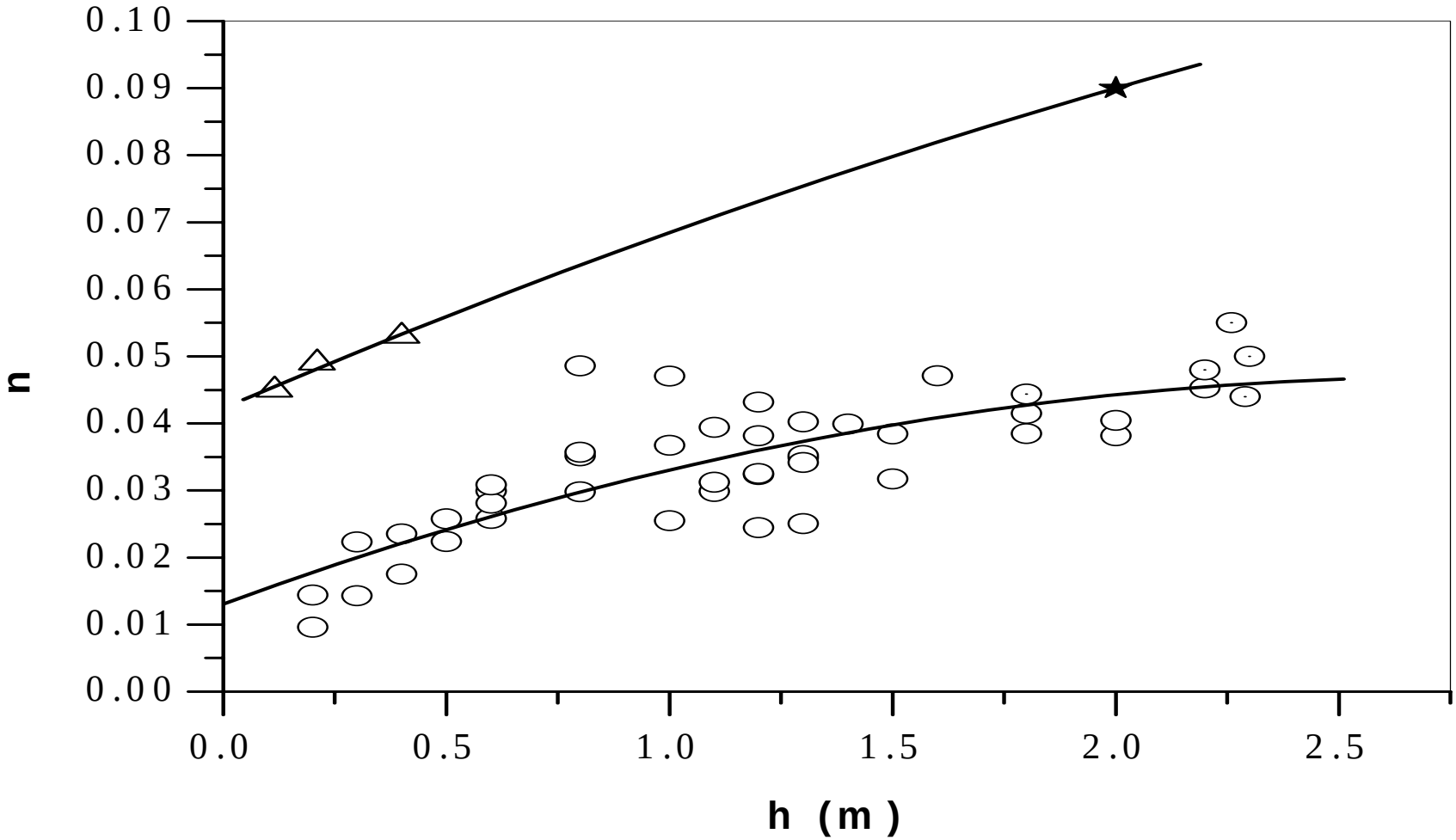
Bimodal Grain Size Distribution


2005


The competent of debris flow is extremely high and is able to transport huge stones.
2005/05/21

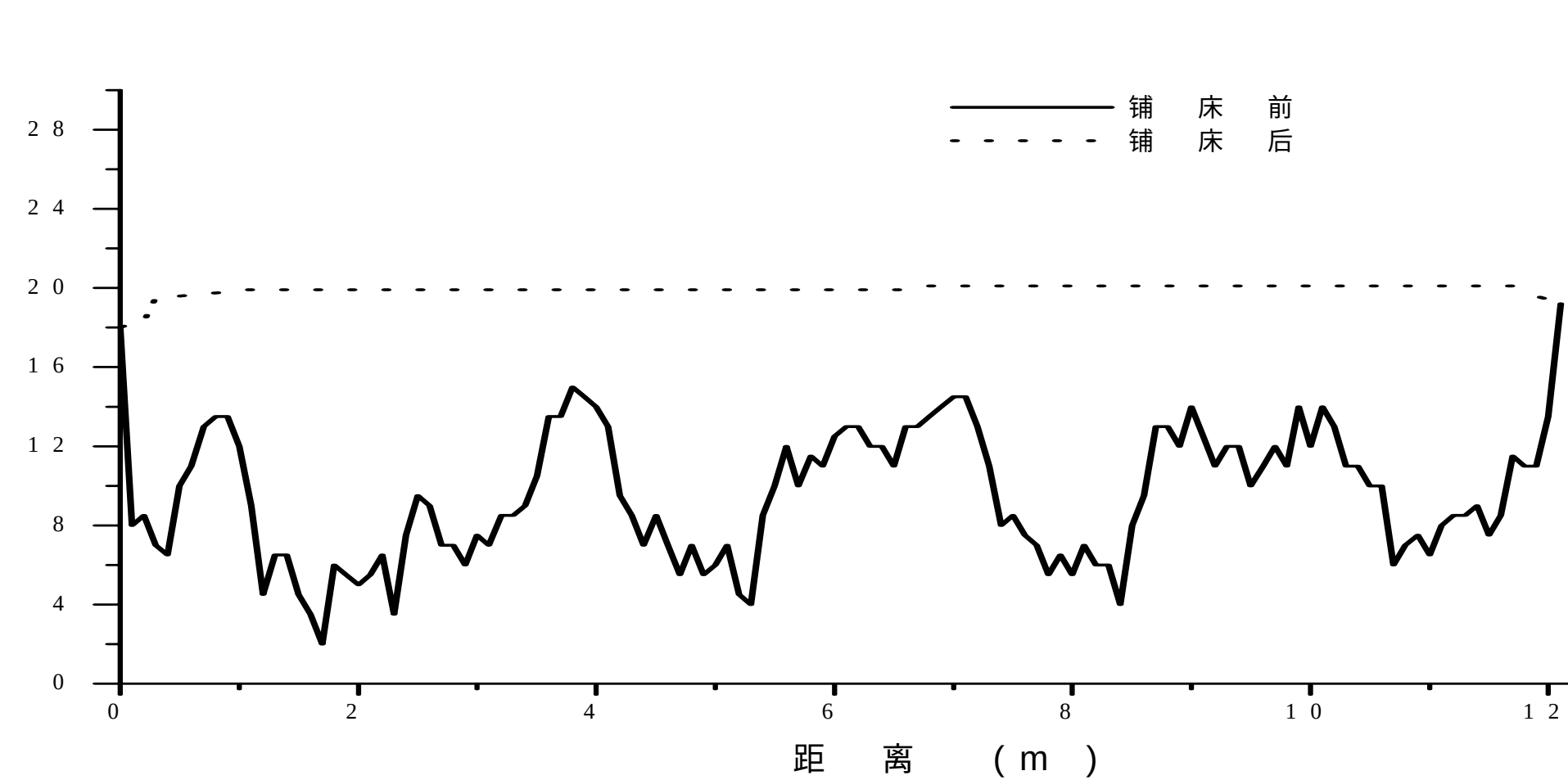
Resistance and drag reduction

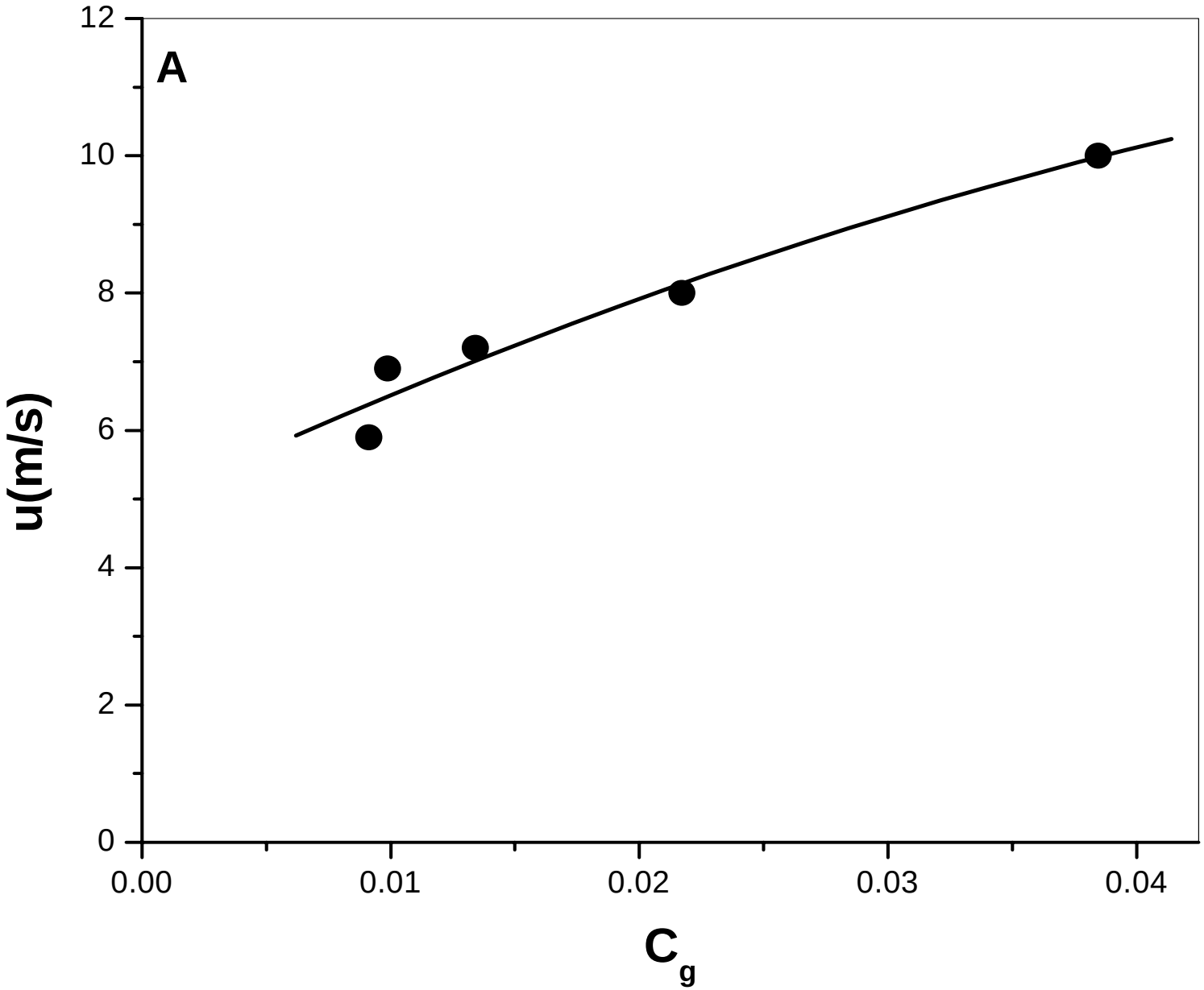
Manning's roughness n (or resistance) in viscous debris flow is much lower than flow of water due to drag reduction

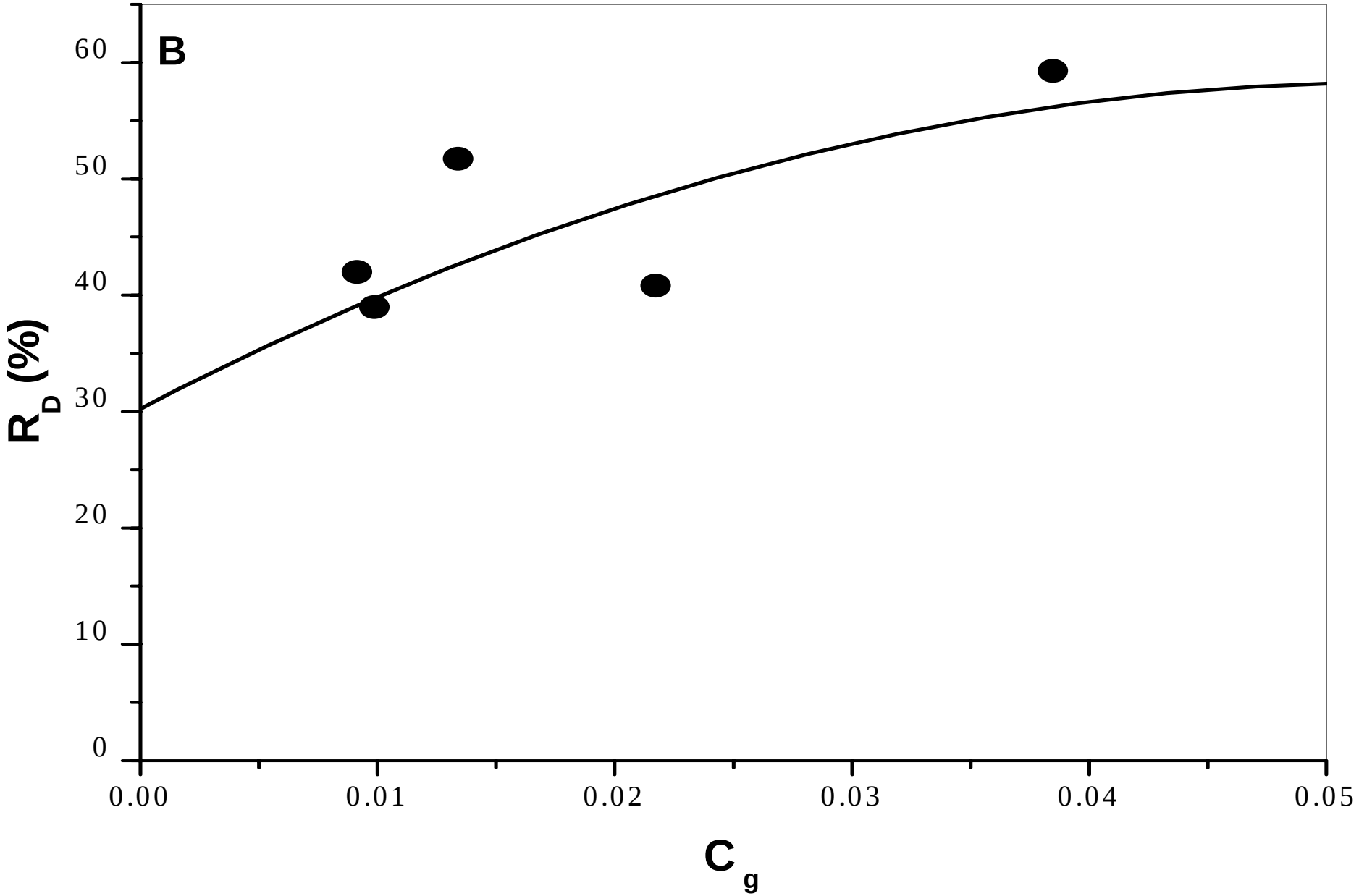


Manning's roughness n versus the depth of flow (circles – viscous debris flow, deltas-water flow

蒋家沟上周泥石流的沉积物Debris flow deposit left by the debris flo
occurred 7 days ago in the Jiangjia ravine-Dongchuan debris flow s


铺 床 前
铺 床 后
28
24
20
16
12
8
4
0
0
2
4
6
8
10
12
距 离 （m ）


A
12
10
8
6
4
2
0
u(m/s)
0.00
0.01
0.02
0.03
0.04
C g


B
60
50
40
30
20
10
0
R_D (%)
0.00
0.01
0.02
0.03
0.04
0.05
C_g