High Velocity Ejection of Large Blocks Inhibited by Impact into Lunar Regolith

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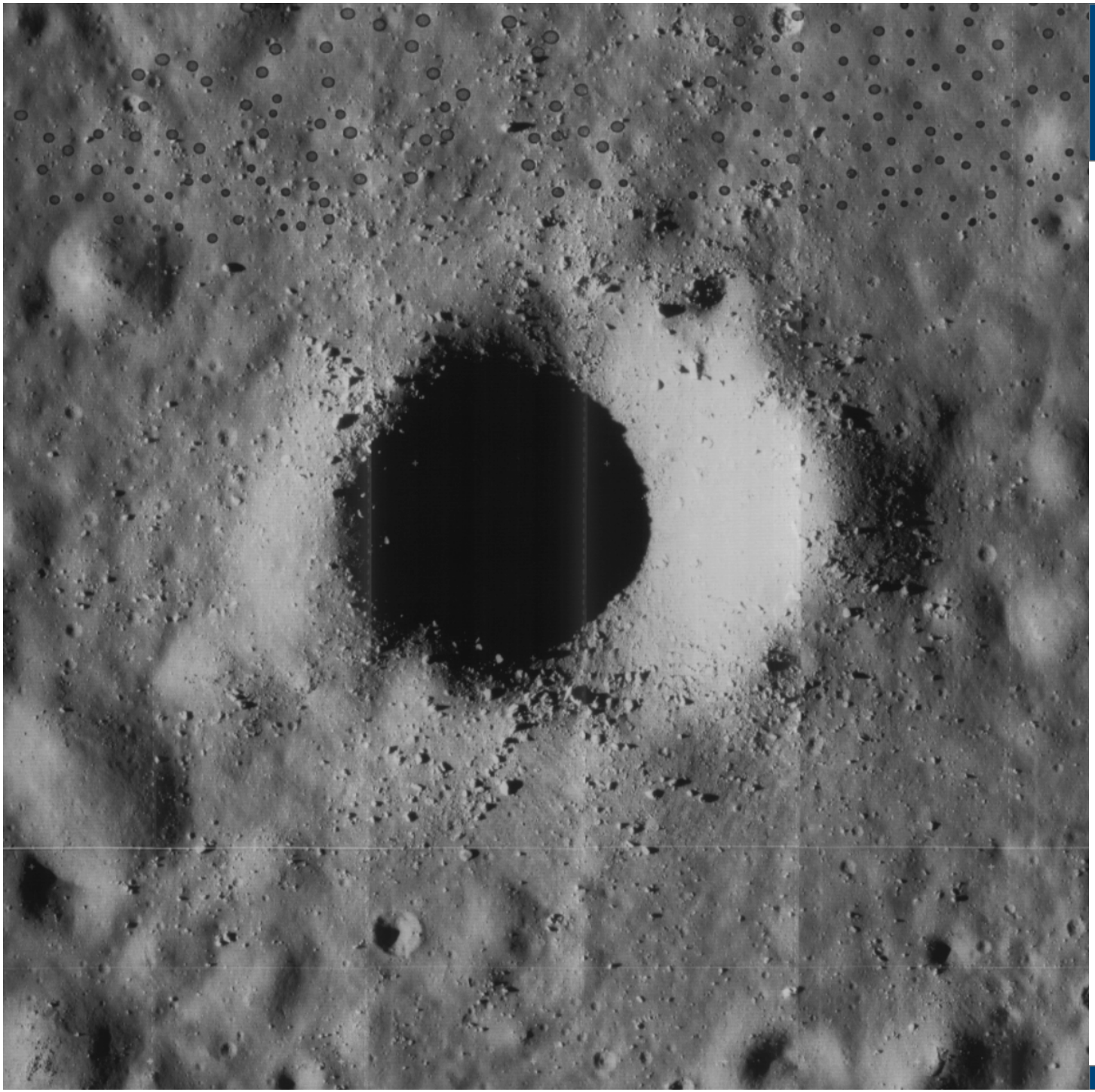
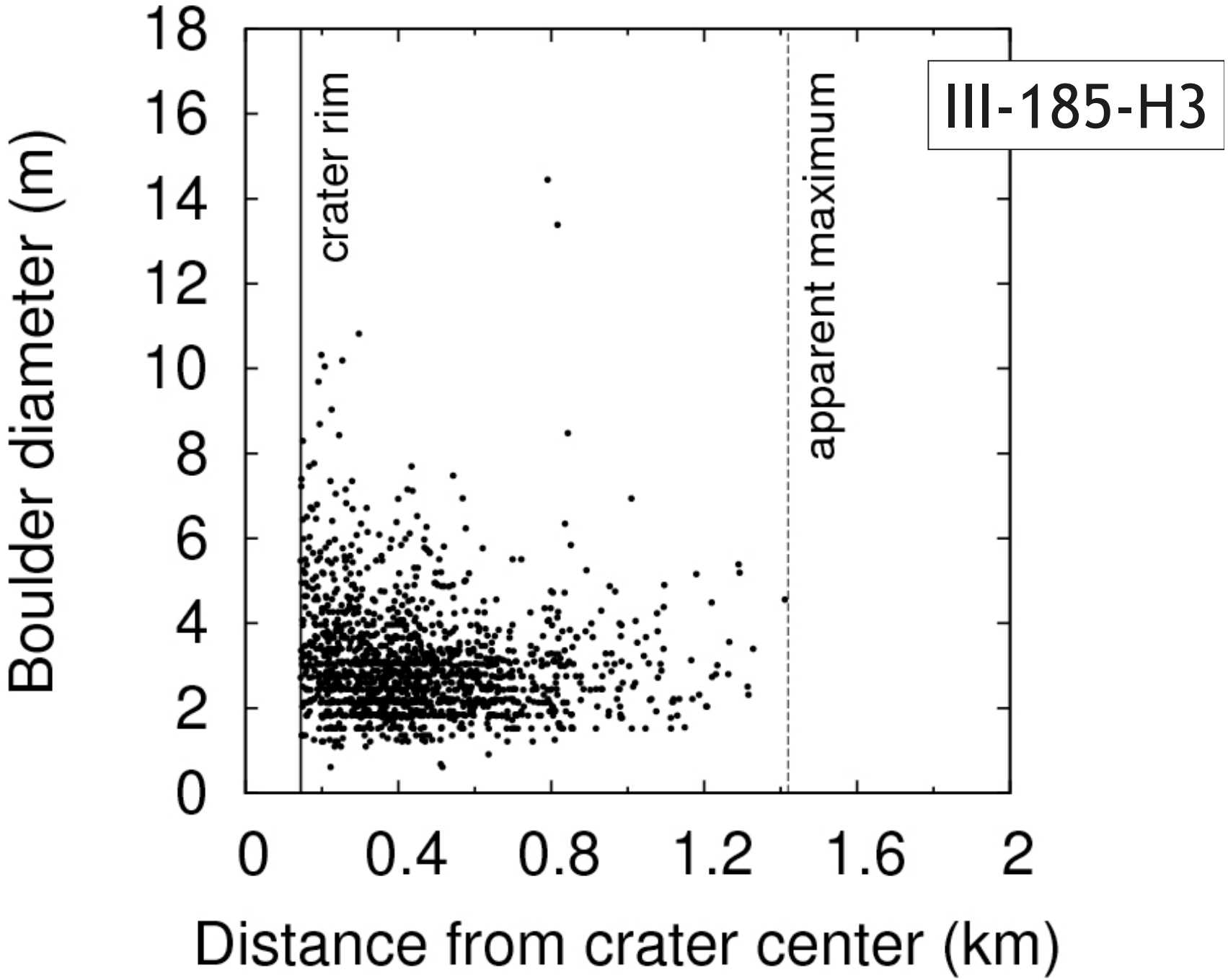
Method

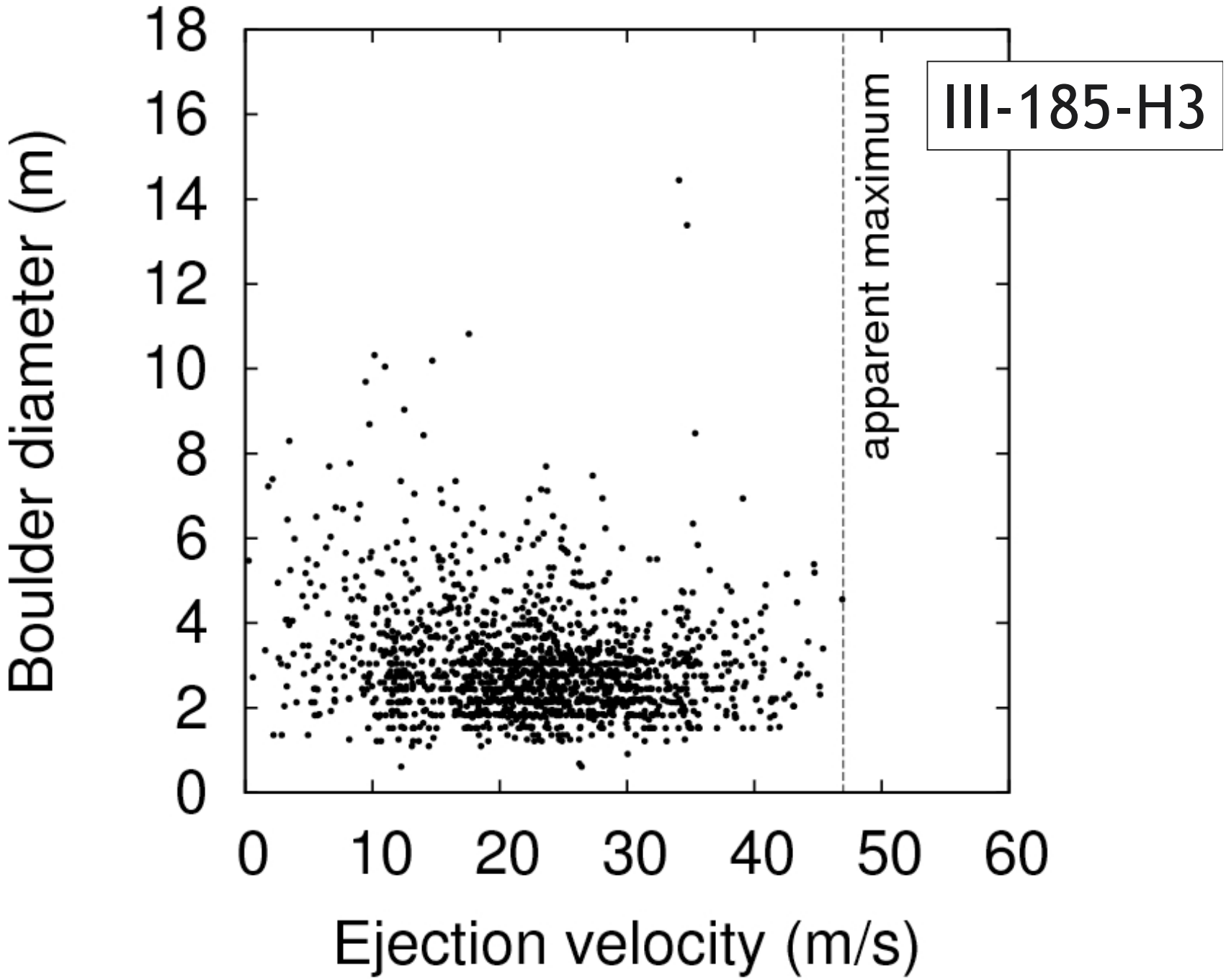
- Studied 10 bouldery lunar craters
- Measured 10,000 ejected boulders
- Calculated ejection velocity
- Measured regolith depth via morphology of nearby small craters (Oberbeck and Quaide, 1968)

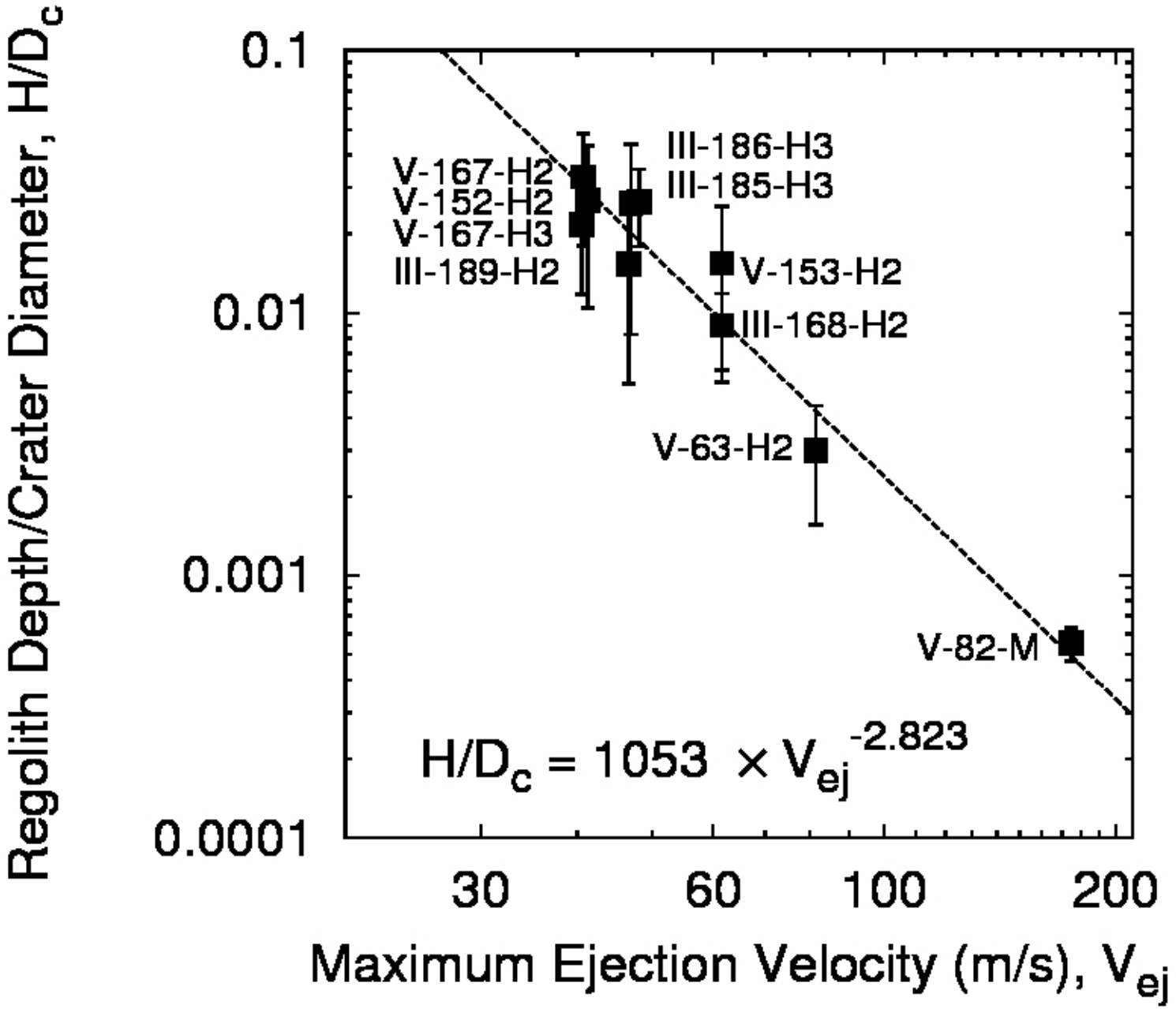


Lunar
Orbiter V
152-H2

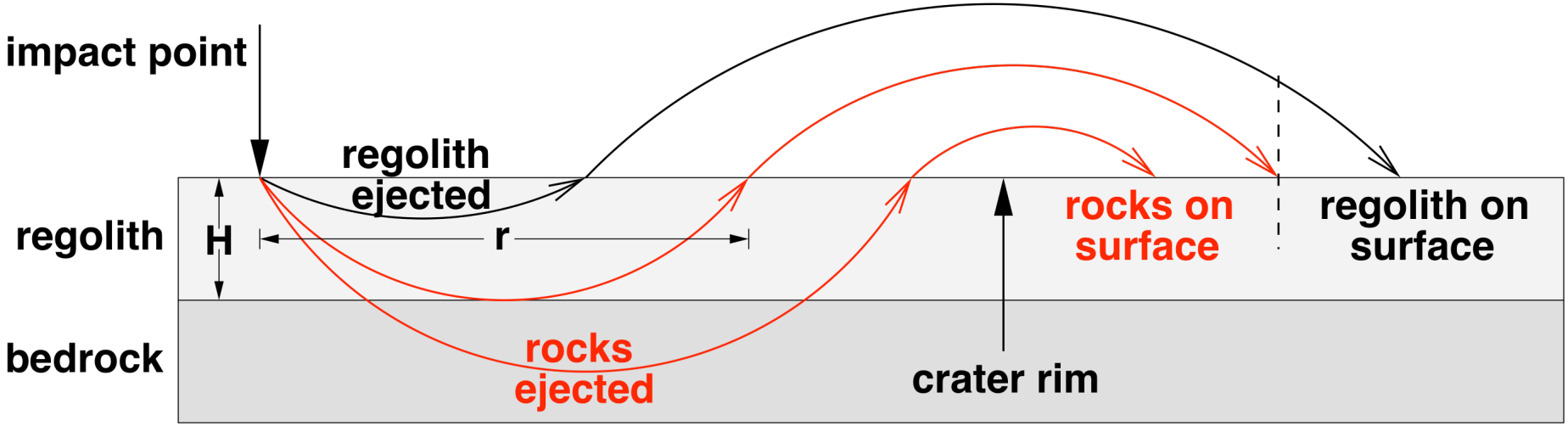
200 m


III-185-H3
crater rim
apparent maximum
Boulder diameter (m)
Distance from crater center (km)
0
2
4
6
8
10
12
14
16
18
0
0.4
0.8
1.2
1.6
2


III-185-H3
apparent maximum
Boulder diameter (m)
Ejection velocity (m/s)
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60


Regolith Depth/Crater Diameter, H/D$_c$
0.1
0.01
0.001
0.0001
30
60
100
200
Maximum Ejection Velocity (m/s), V$_{ej}$
V-167-H2
V-152-H2
V-167-H3
III-189-H2
III-186-H3
III-185-H3
V-153-H2
III-168-H2
V-63-H2
V-82-M
H/D$_c$ = 1053 × V$_{ej}$$^{-2.823}$

Our Hypothesis



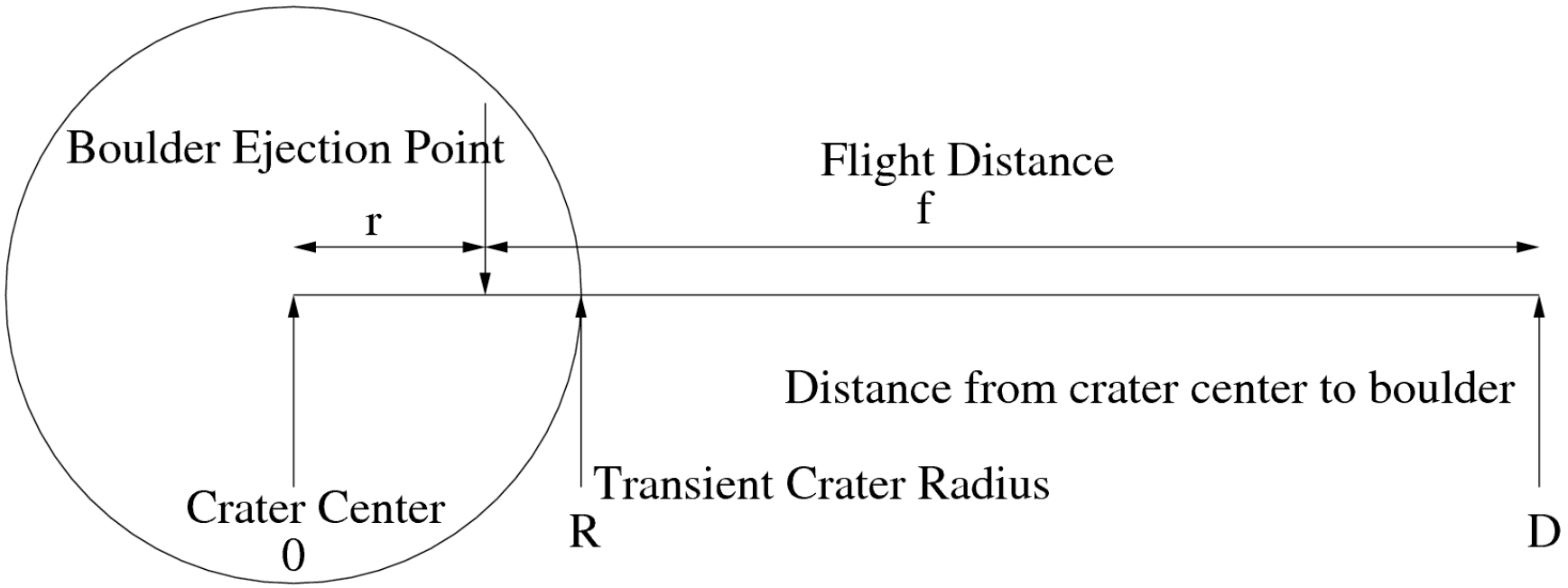
- Must penetrate to rock to eject boulders
- Deeper streamlines eject closer to rim

Implications

- Meteorites:
  - Less likely – deep regolith
  - More likely – shallow or no regolith
- Distant secondary craters
  - Less likely – deep regolith
  - More likely – shallow or no regolith
- Landing site selection
  - Fewer distant boulders – deep regolith
  - More distant boulders – shallow or no regolith

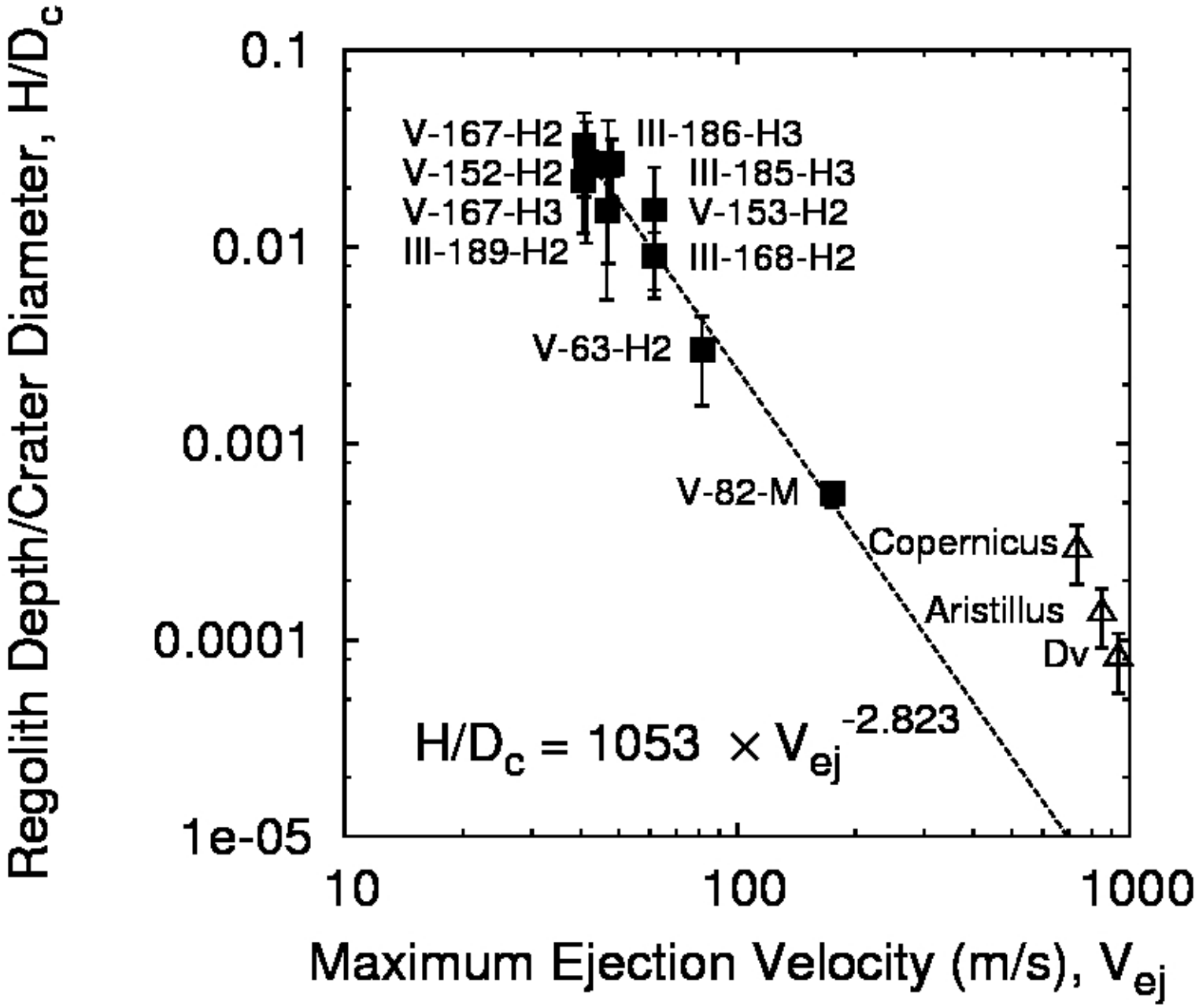
The End

Calculation of Ejection Velocity



Craters Studied

Photo Number	Longitude	Latitude	Terrain
III-168-H2	43.6 W	2.0 S	mare
III-185-H3	43.6 W	2.0 S	mare
III-186-H3	43.6 W	2.0 S	mare
III-189-H2	43.6 W	2.0 S	mare
V-63-H2	32.8 E	0.4 S	highlands
V-82-M	18.1 E	2.7 N	highlands
V-167-H2	30.9 W	12.9 N	highlands
V-167-H3	30.9 W	12.9 N	highlands
V-152-H2	20.2 W	10.1 N	Cop. ej. blanket
V-153-H2	20.2 W	10.1 N	Cop. ej. blanket


Regolith Depth/Crater Diameter, H/D$_c$
0.1
0.01
0.001
0.0001
1e-05
10
100
1000
Maximum Ejection Velocity (m/s), V$_{ej}$
V-167-H2
V-152-H2
V-167-H3
III-189-H2
III-186-H3
III-185-H3
V-153-H2
III-168-H2
V-63-H2
V-82-M
Copernicus
Aristillus
Dv
H/D$_c$ = 1053 × V$_{ej}$$^{-2.823}$