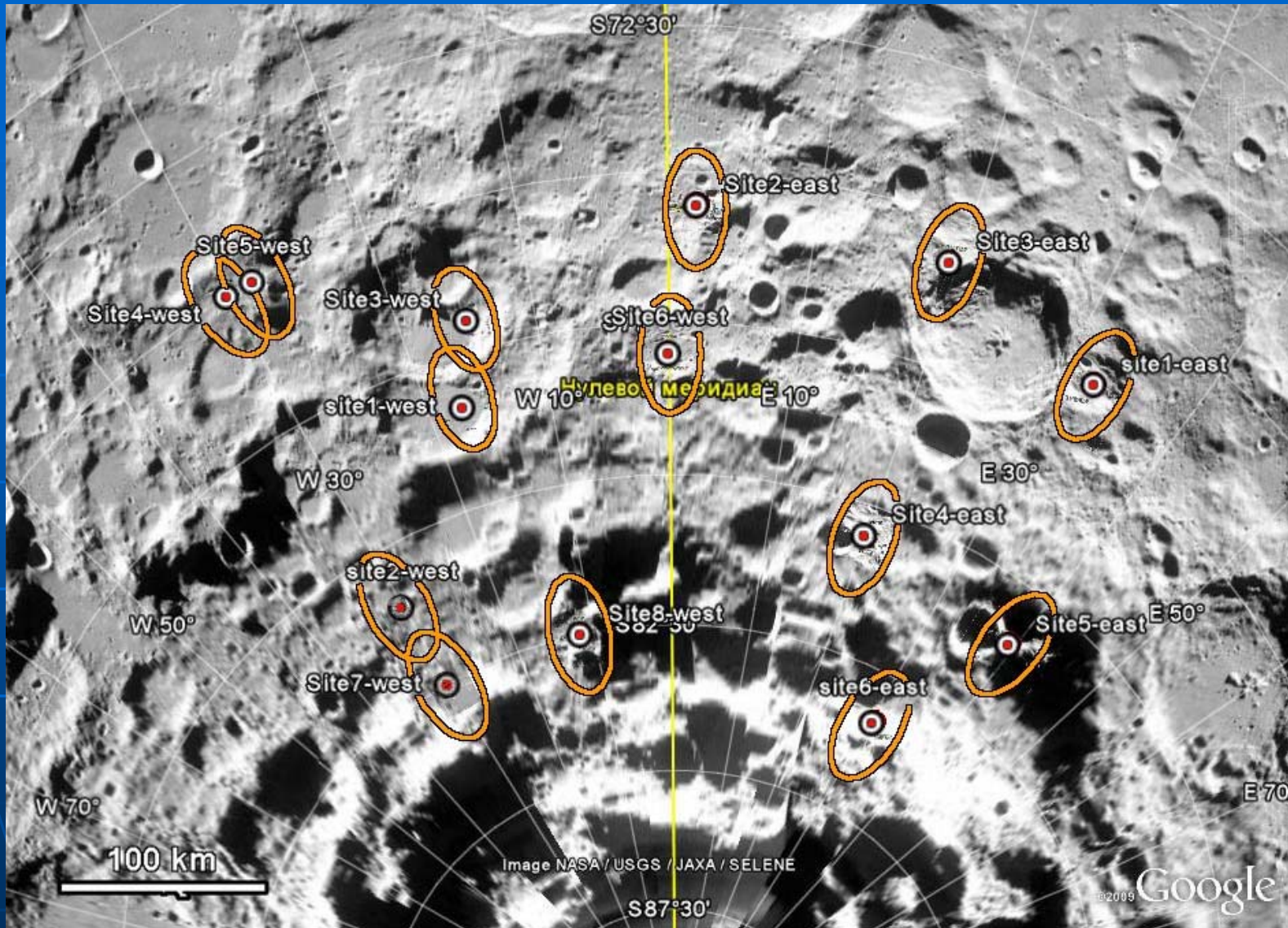


Surface properties analysis of possible Luna - Resource / Glob landing sites basing on the orbital data

A.M. Abdrakhimov
(Vernadsky Institute)



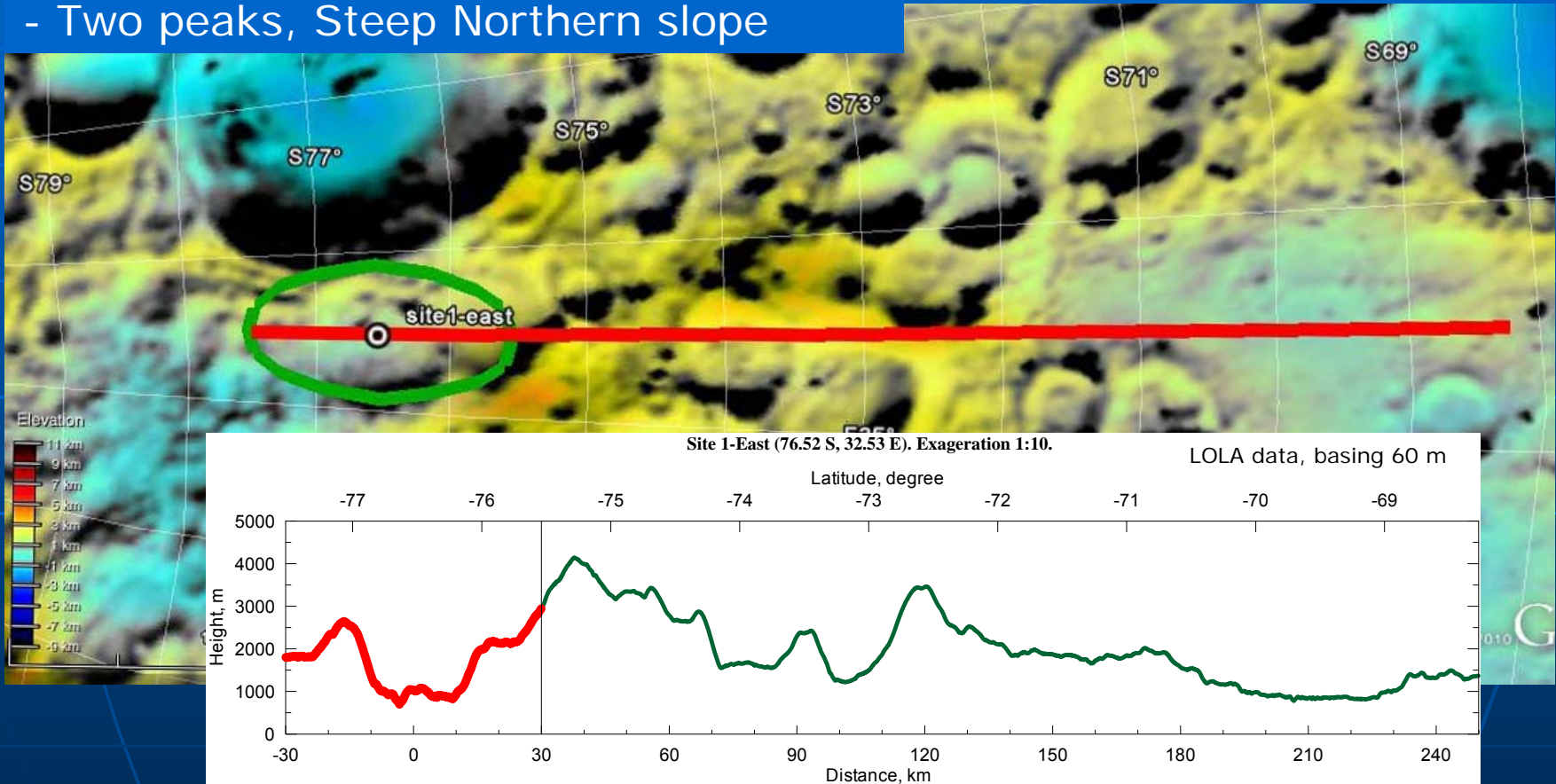
The LEND team, IKI, suggested 14 candidate sites: Lower neutron flux / higher H₂O content; not in permanent shadow; 60x30 km landing ellipse. Using Kaguya images and LOLA data the least risky sites were estimated

Site 1-East (76.52 S, 32.53 E)

280-km Approach Track

- High Altitude Range of rough highland terrain
- Two peaks, Steep Northern slope

Altitude Range	3442 m
Average Slope	5 deg.
Max. Slope	25 deg.
Slope >15 deg	4%

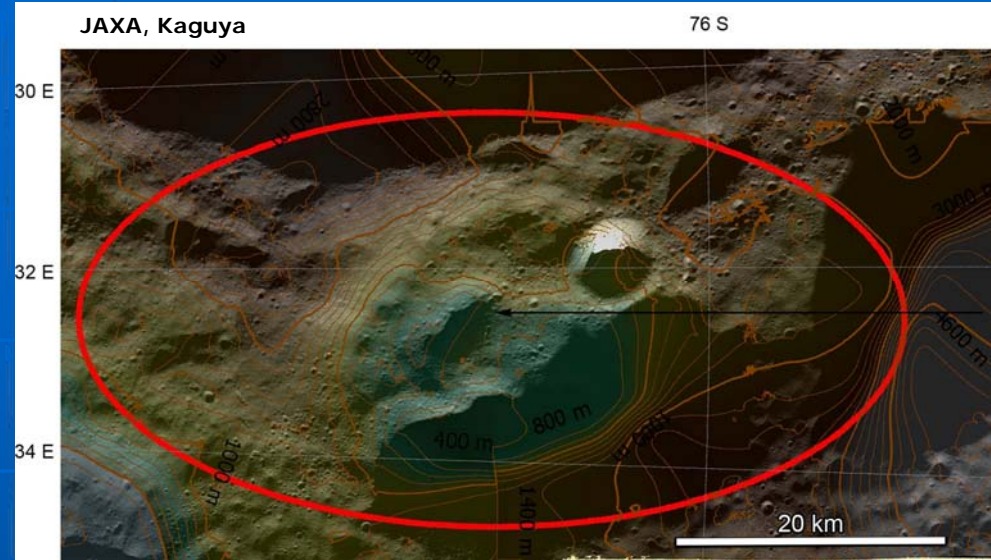


The approach track goes along very rough highland terrain with altitude range ~ 3.5 km.

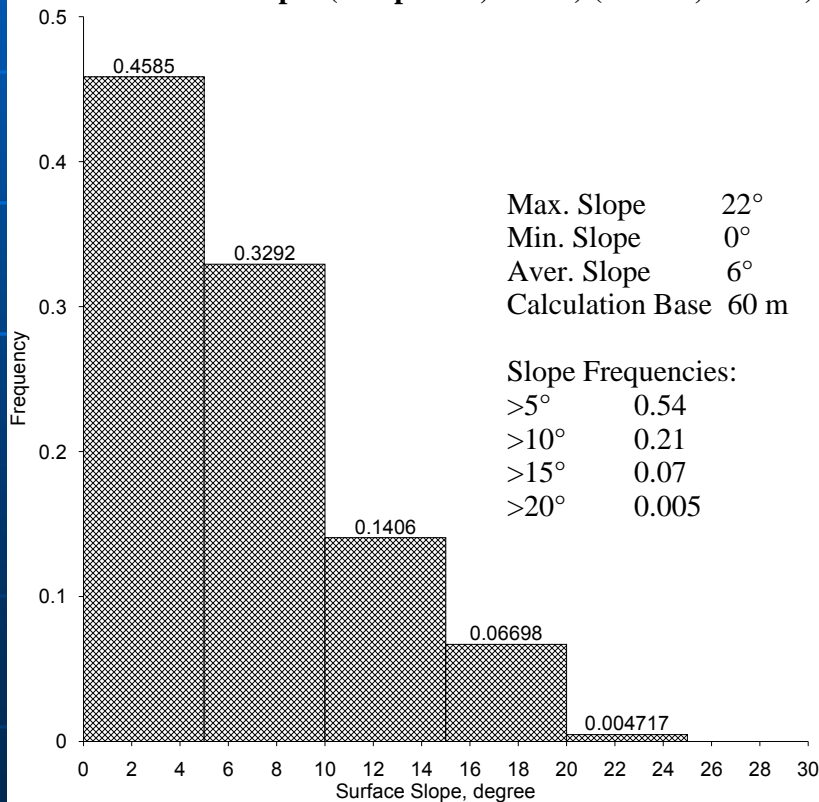
Site 1-East Ellipse (60x30 km)

(76.52 S, 32.53 E)

Altitude Range	2251 m
Average Slope	6 deg.
Max. Slope	22 deg.
Slope >15 deg, (60 m base)	7%



Site 1-East Ellipse (N-S profile, 60 km) (76.52 S, 32.53 E)



-Very Rough highland terrain within the ellipse

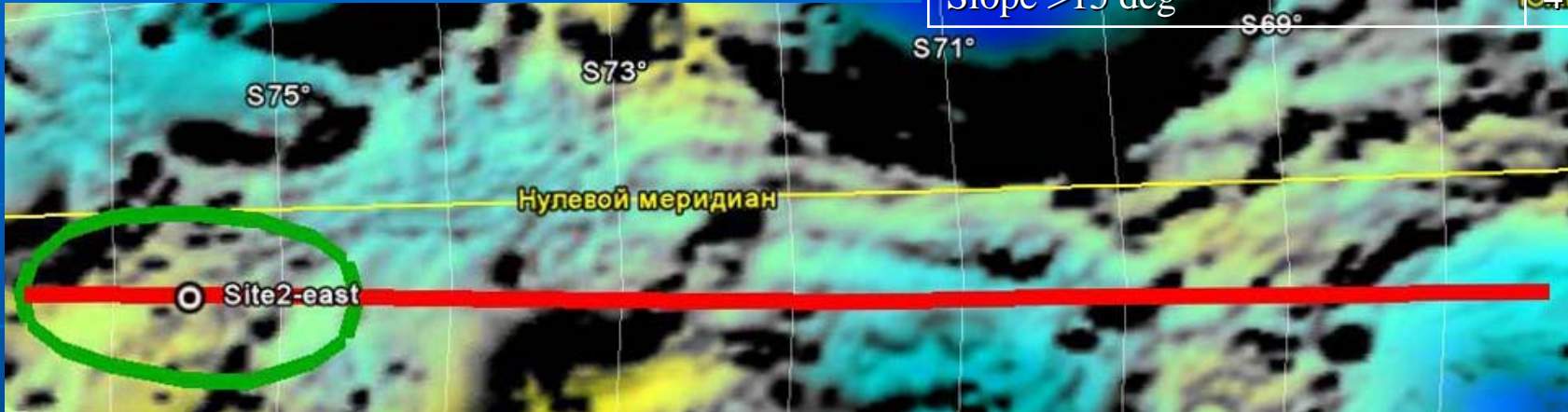
Our Estimation:
Landing is too risky!

Site 2-East (75.54 S, 1.97 E)

280-km Approach Track

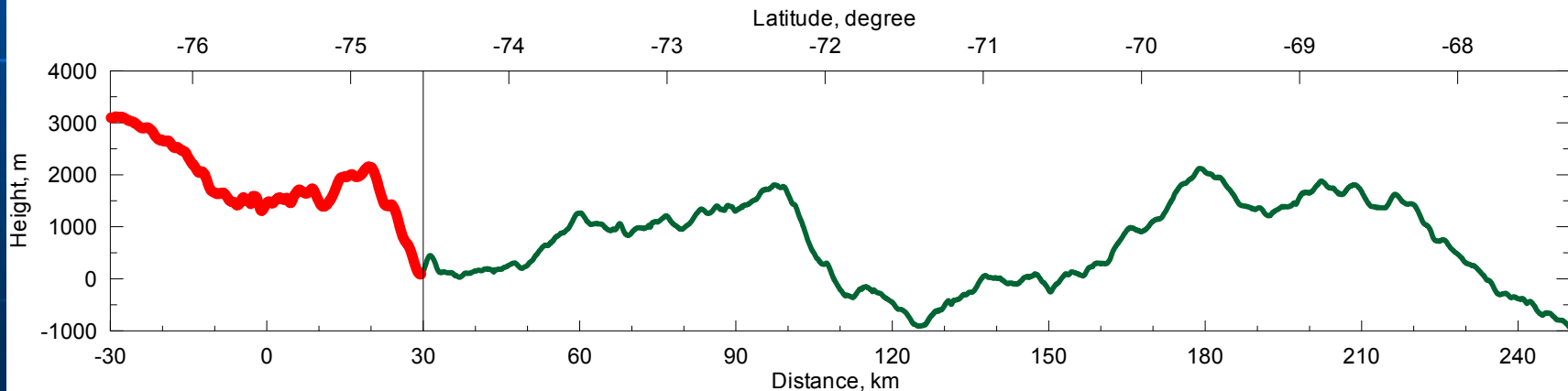
- High Altitude Range of rough highland terrain
- Steep Southern slope before landing

Altitude Range	4051 m
Average Slope	6 deg.
Max. Slope	26 deg.
Slope >15 deg	4%



Site 2-East (75.54 S, 1.97 E). Exageration 1:10.

LOLA data, basing 60 m

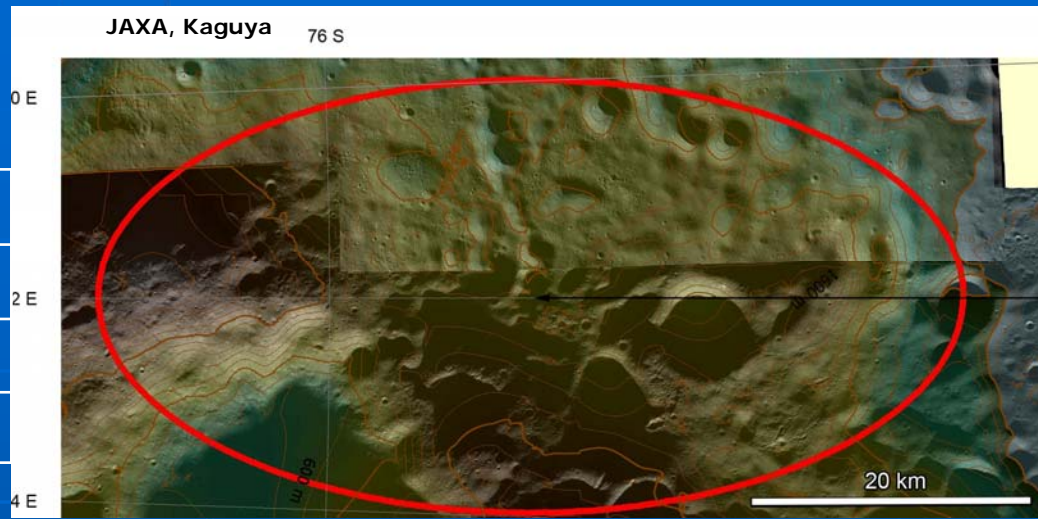


The approach track goes through rough highland terrain to southern steep slope.

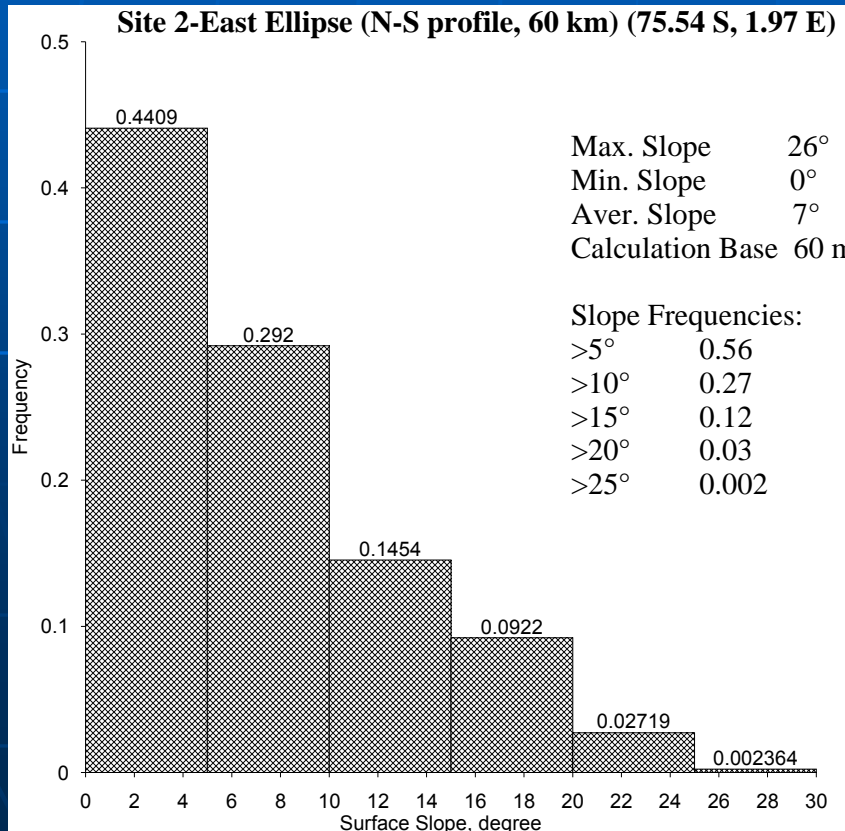
Site 2-East Ellipse (60x30 km)

(75.54 S, 1.97 E)

Altitude Range	3032 m
Average Slope	7 deg.
Max. Slope	26 deg.
Slope >15 deg, (60 m base)	7 %



- Very Rough highland terrain within the ellipse



Our Recommendation: to shift the site to SSE to less the altitude range within ellipse

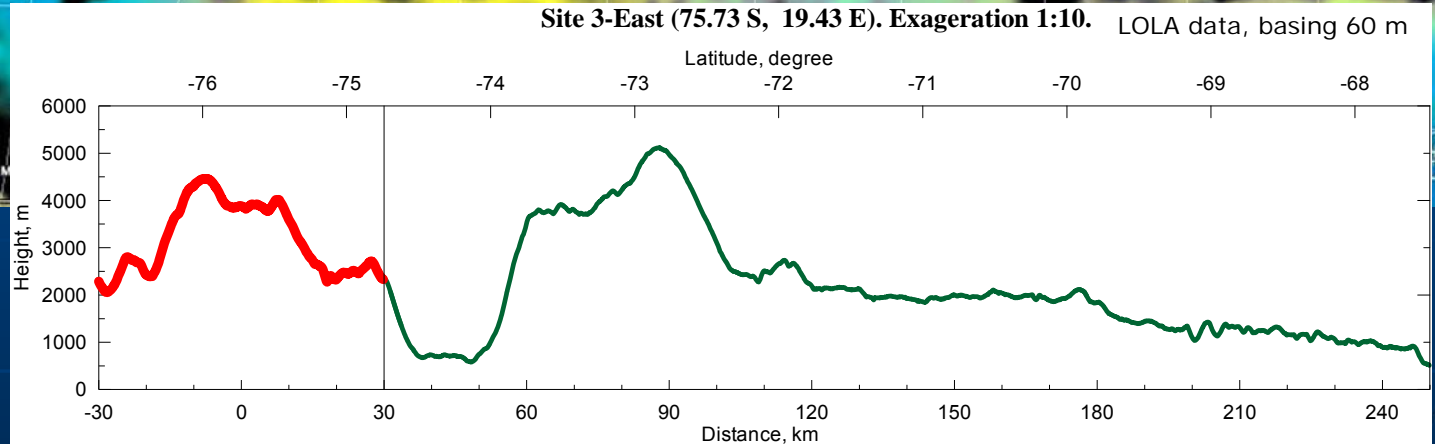
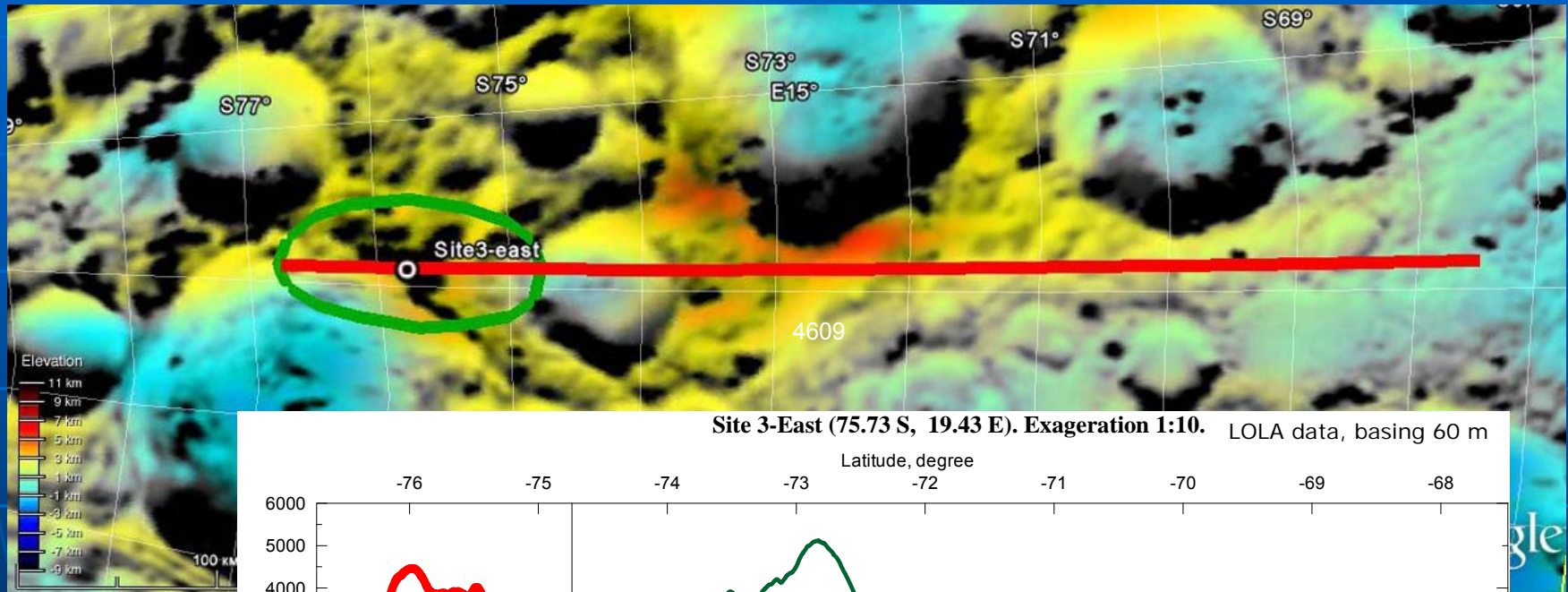
Our Estimation:
Landing site is reserved!

Site 3-East (75.73 S, 19.43 E)

280-km Approach Track

- Too High Range of rough highland terrain altitude

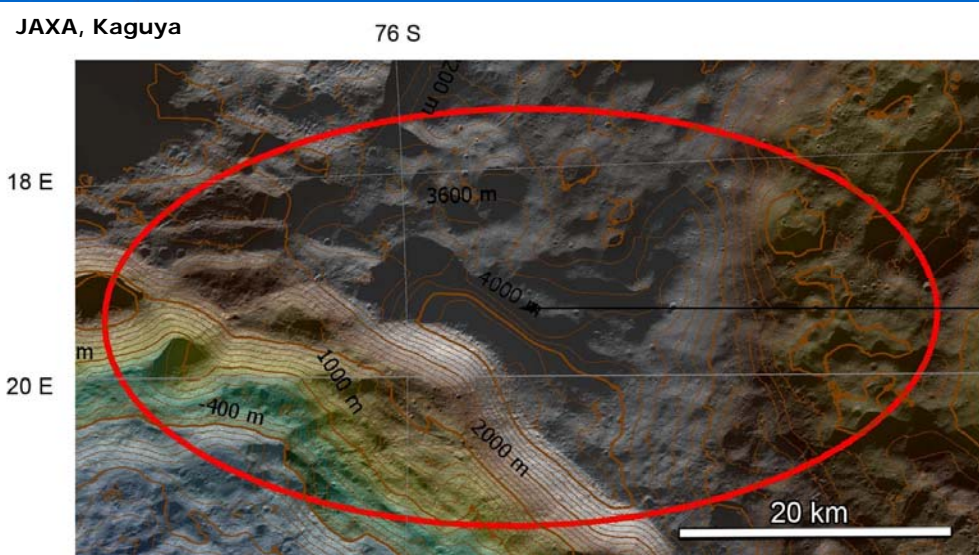
Altitude Range	4609 m
Average Slope	6 deg.
Max. Slope	27 deg.
Slope >15 deg	5.5 %



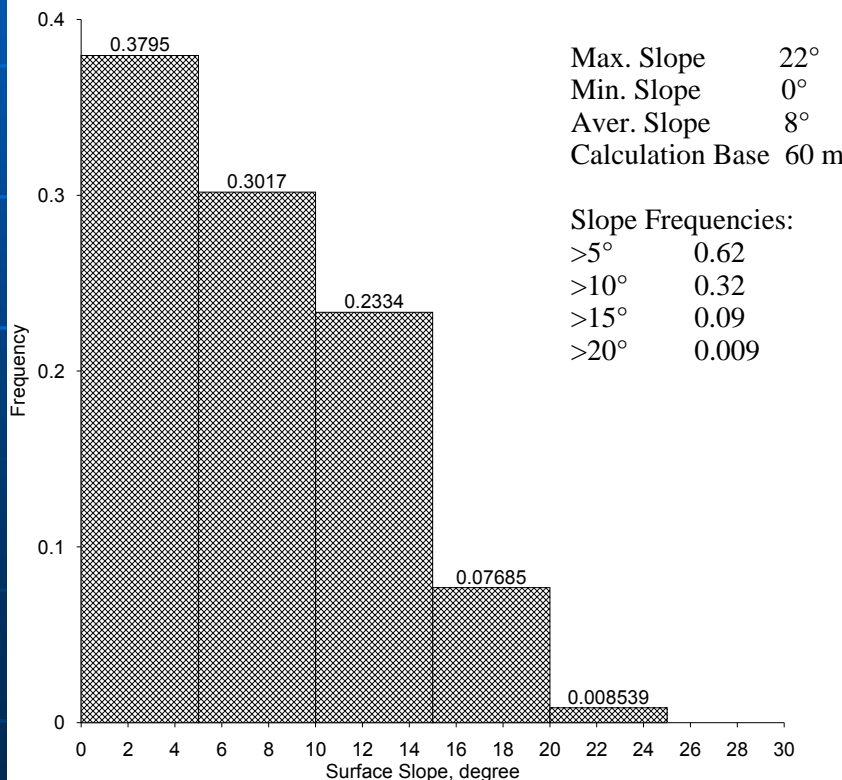
The approach track goes along very rough highland terrain with altitude range ~4.6 km.

Site 3-East Ellipse (60x30 km) (75.73 S, 19.43 E)

Altitude Range	2405 m
Average Slope	8 deg.
Max. Slope	22 deg.
Slope >15 deg, (60 m base)	9%



Site 3-East Ellipse (N-S profile, 60 km) (75.73 S, 19.43 E)



- Very Rough highland
- Steep NW slope of large crater within the ellipse

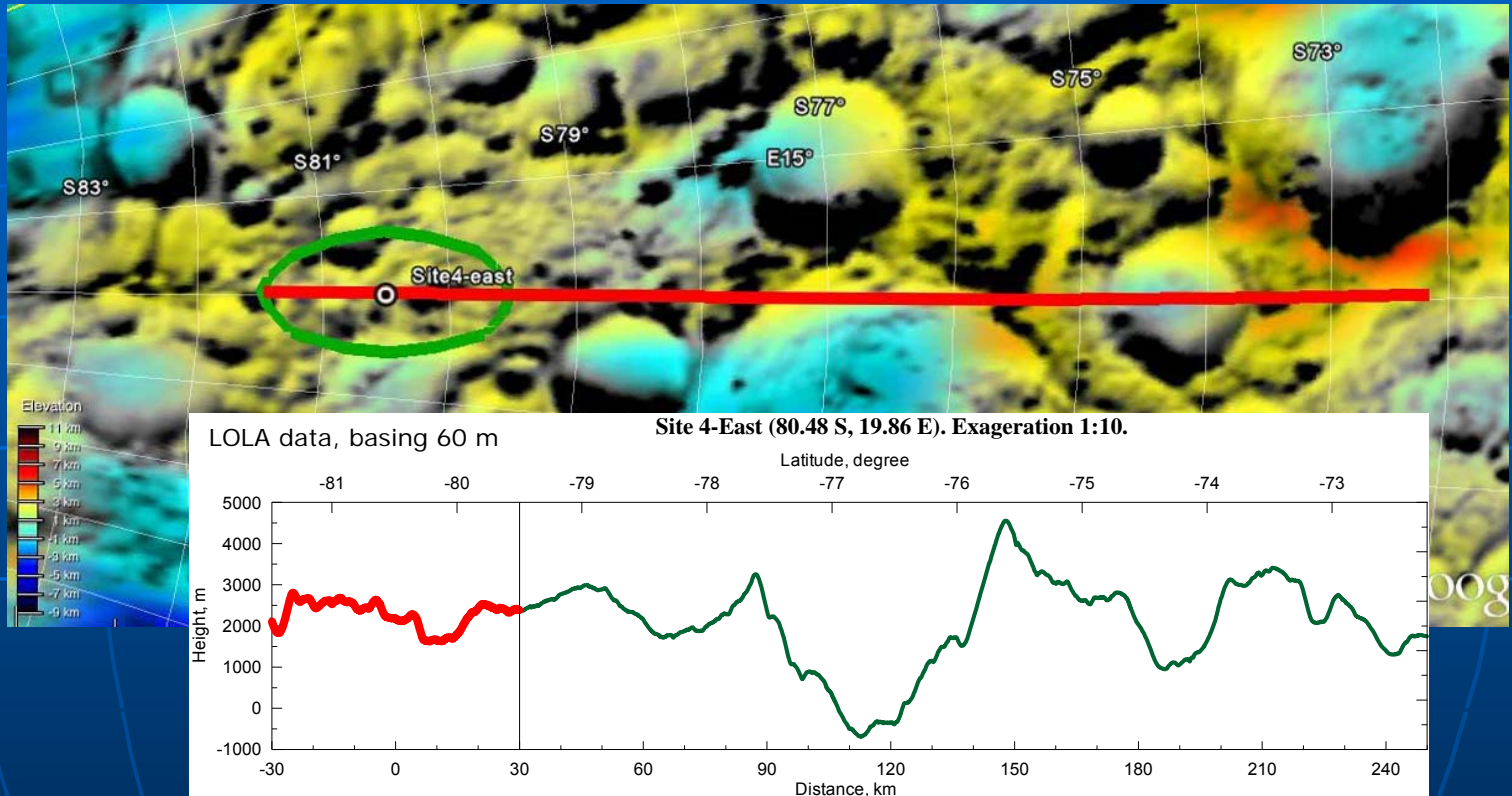
Our Estimation:
Landing is too risky!

Site 4-East (80.48 S, 19.86 E)

280-km Approach Track

Rough highland terrain

Altitude Range	5250 m
Average Slope	7 deg.
Max. Slope	27 deg.
Slope >15 deg	10 %

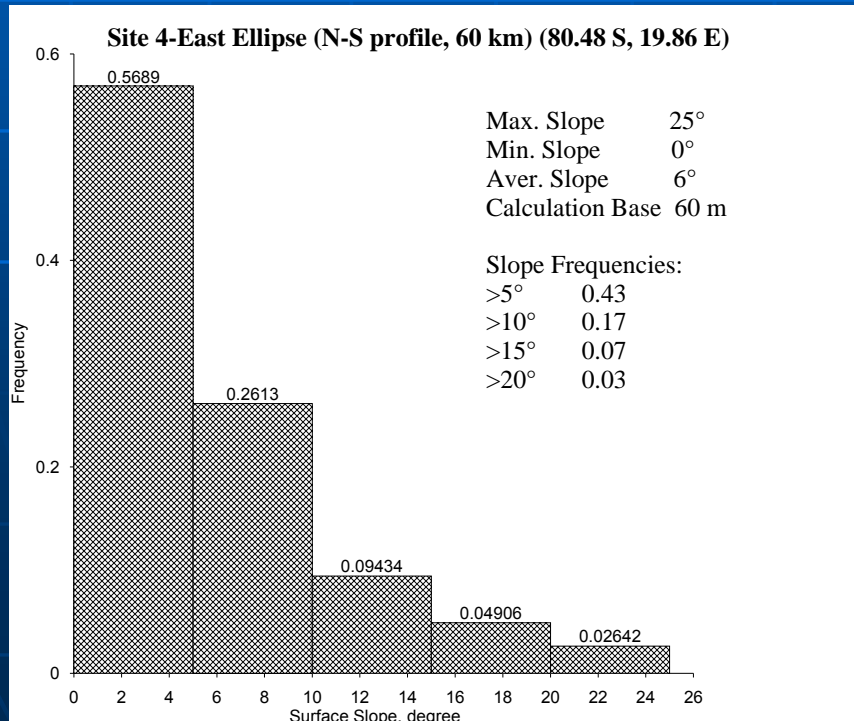
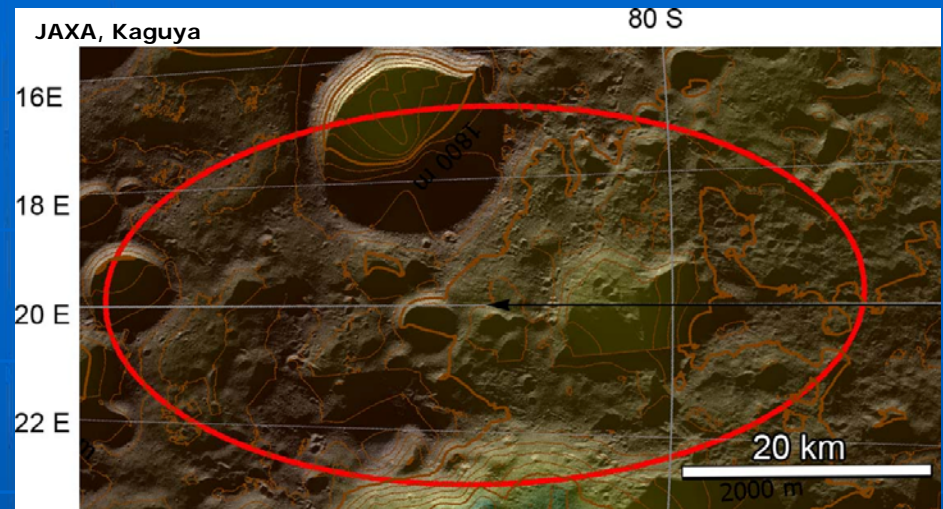


The track goes along very rough highland terrain with altitude range ~5 km approaching the relatively smooth place at highland terrain.

Site 4-East Ellipse (60x30 km)

(80.48 S, 19.86 E)

Altitude Range	1176 m
Average Slope	6 deg.
Max. Slope	25 deg.
Slope >15 deg, (60 m base)	7%



+ Relatively Less Rough
Highland Terrain
- 30 km Crater in the western
part

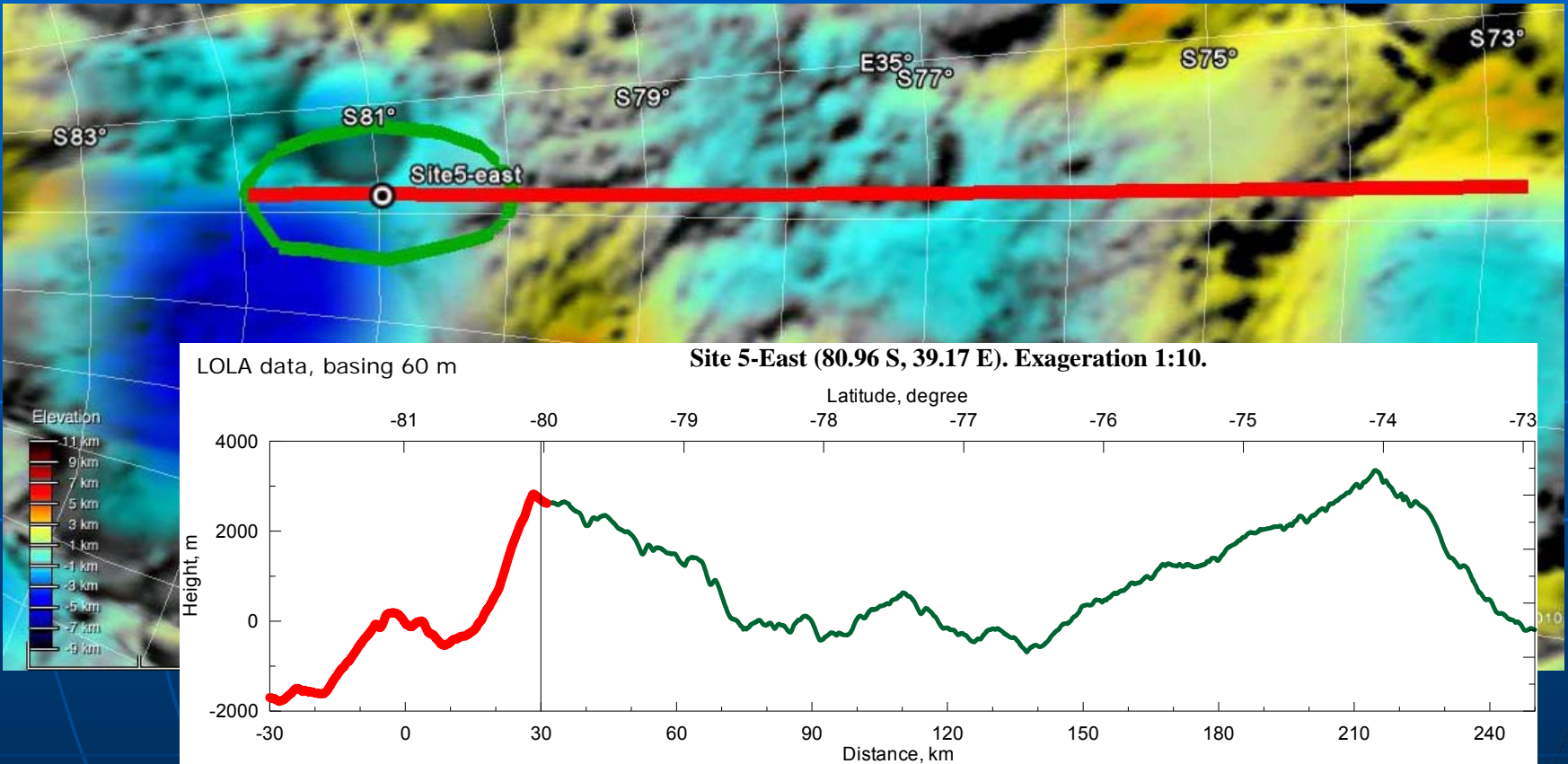
Our Estimation:
Landing site could be
recommended

Site 5-East (80.96 S, 39.17 E)

280-km Approach Track

Very Rough highland terrain

Altitude Range	5138 m
Average Slope	6 deg.
Max. Slope	29 deg.
Slope >15 deg	4%

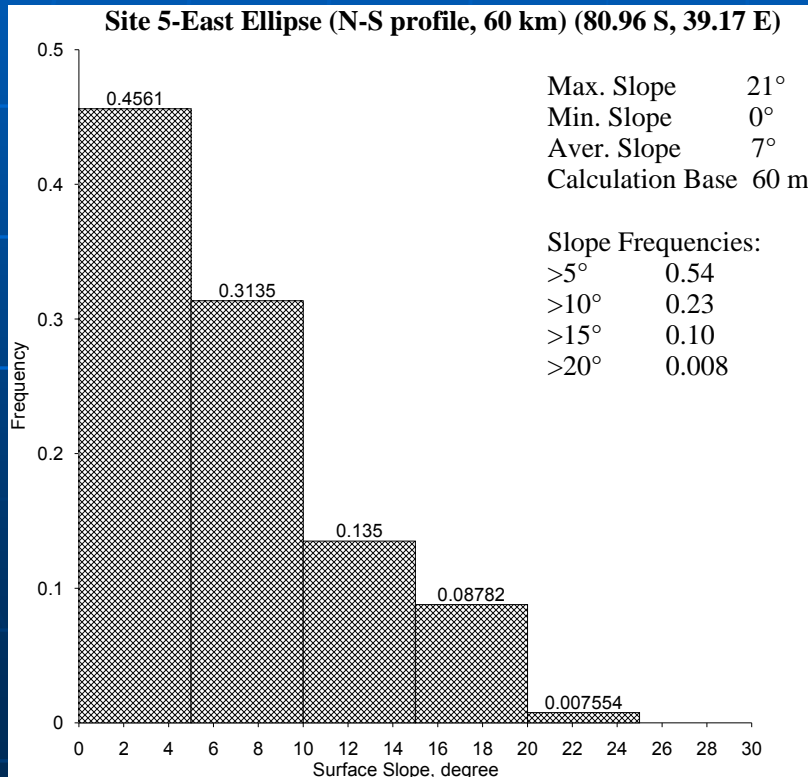
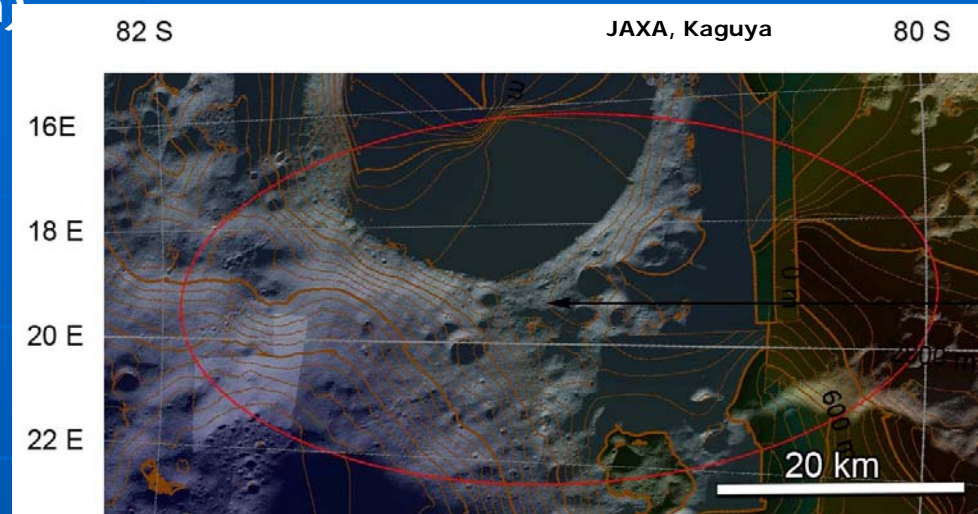


The track goes along highly rough highland terrain with altitude range more 5 km approaching the NE steep crater slope.

Site 5-East Ellipse (60x30 km)

(80.96 S, 39.17 E)

Altitude Range	4608 m
Average Slope	7 deg.
Max. Slope	21 deg.
Slope >15 deg, (60 m base)	10%



- Very Rough highland terrain with high altitude range
- Steep Large Craters Slopes in the W and SE parts

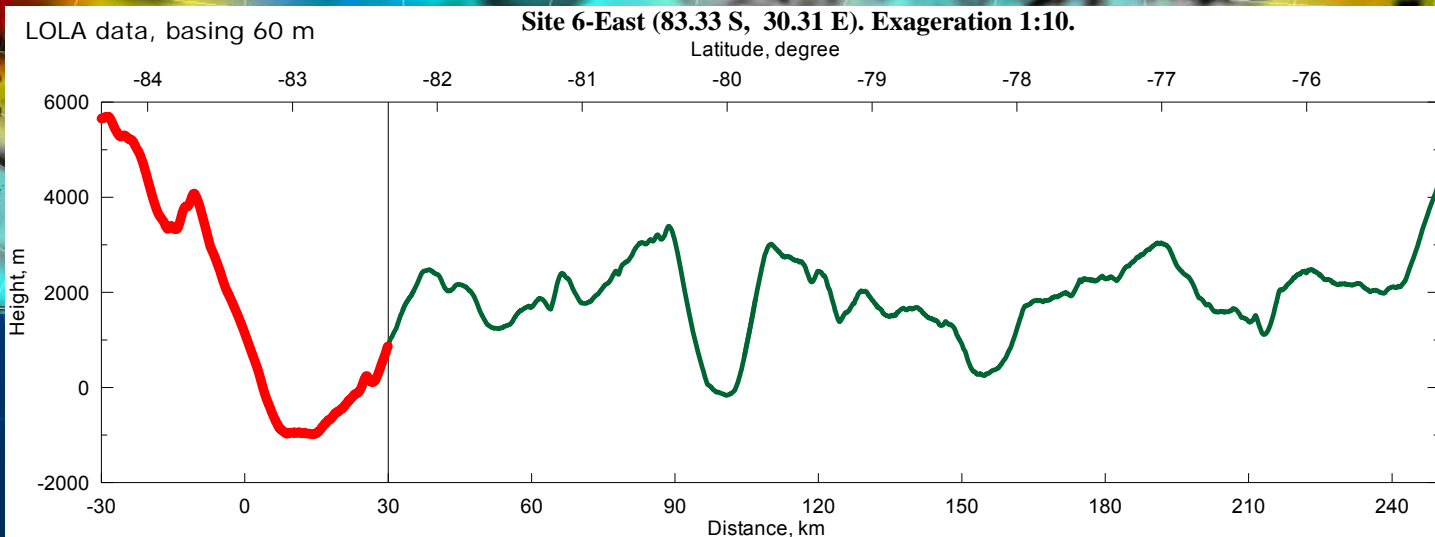
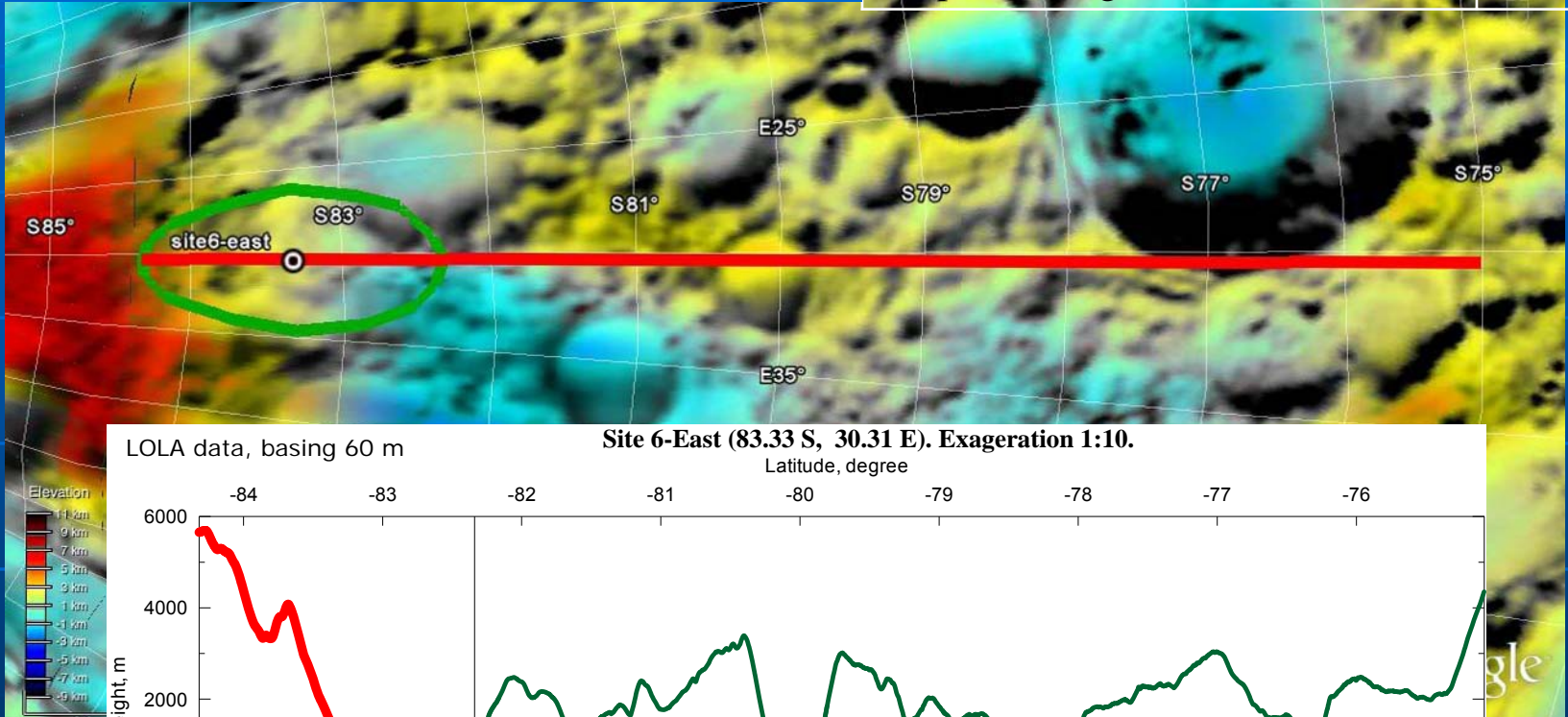
Our Estimation:
Landing is too risky!

Site 6-East (83.33 S, 30.31 E)

280-km Approach Track

- Rough highland terrain with too high altitude range

Altitude Range	6674 m
Average Slope	8 deg.
Max. Slope	32 deg.
Slope >15 deg	18%



The track goes along highland terrain approaching the highly rough place.

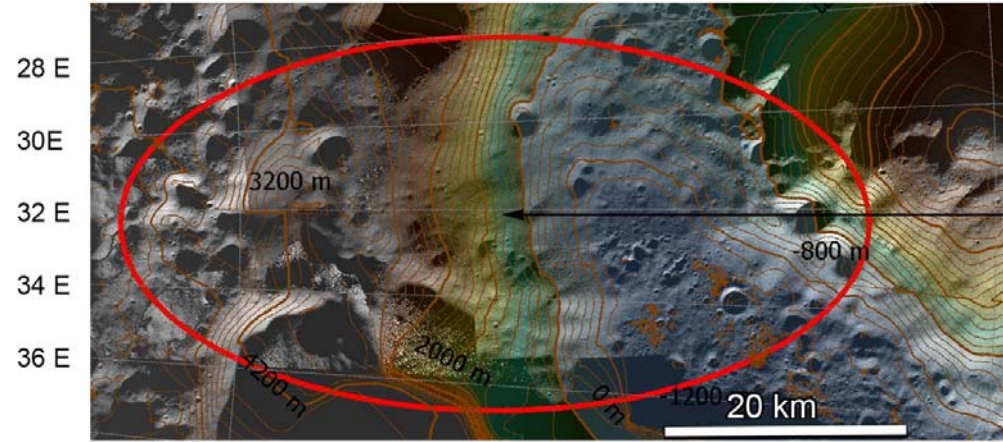
Site 6-East Ellipse (60x30 km)

(83.33 S, 30.31 E)

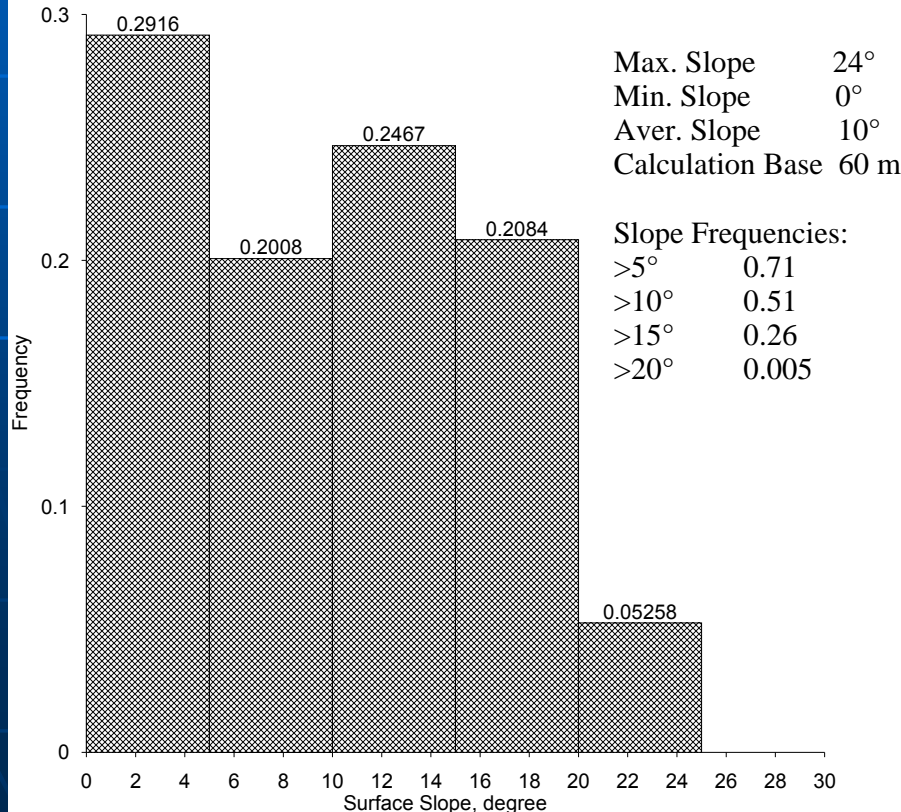
Altitude Range	6674 m
Average Slope	10 deg.
Max. Slope	24 deg.
Slope >15 deg, (60 m base)	26 %

JAXA, Kaguya 84 S

82 S



Site 6-East Ellipse (N-S profile, 60 km) (83.33 S, 30.31 E)



- Very Rough highland terrain with high altitude range (6 km)

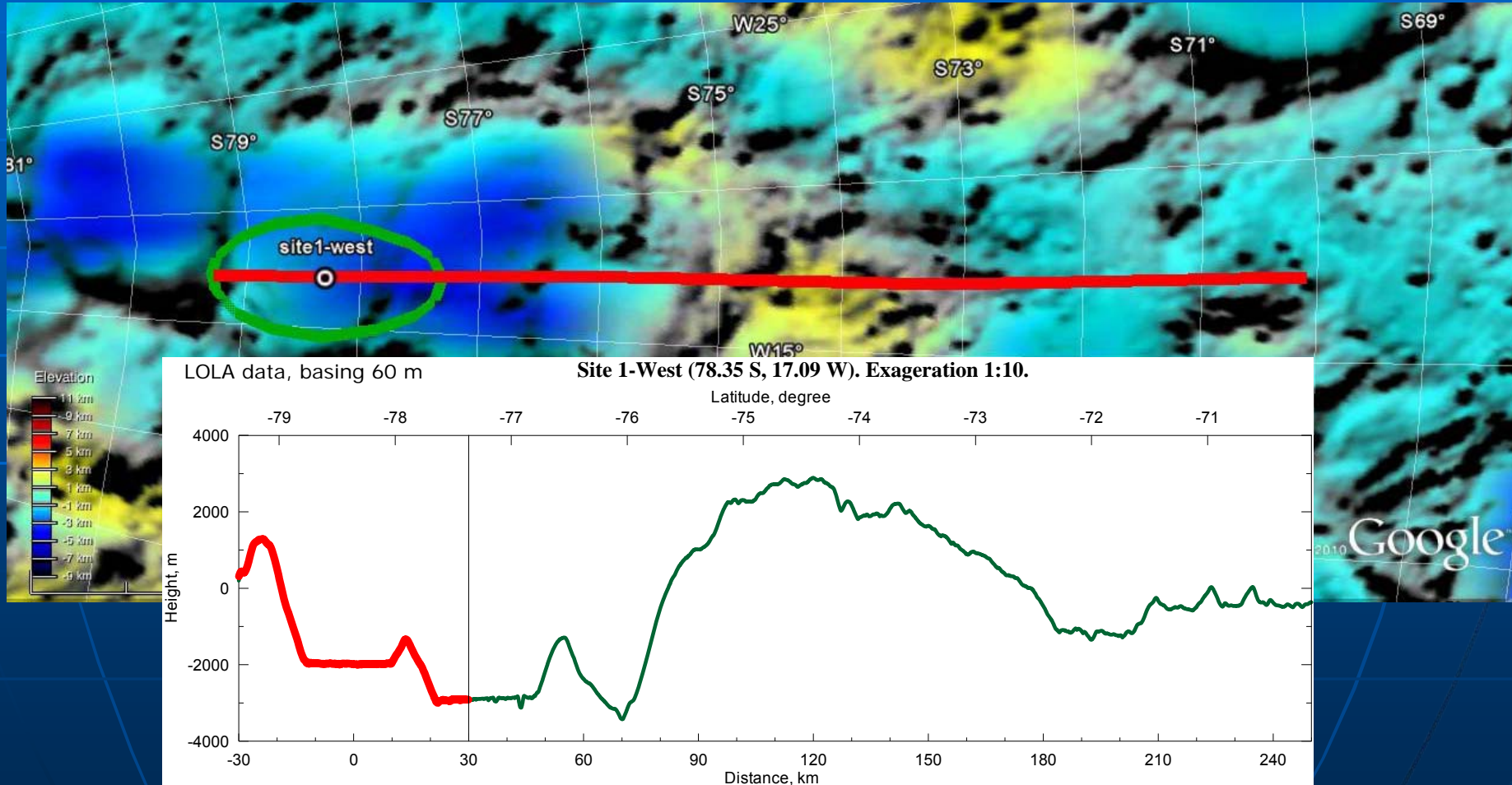
Our Estimation:
Landing is too risky!

Site 1-West (78.35 S, 17.09 W)

280-km Approach Track

Rough highland terrain and smooth crater basins with steep rim slopes

Altitude Range	6315 m
Average Slope	7 deg.
Max. Slope	33 deg.
Slope >15 deg	10 %

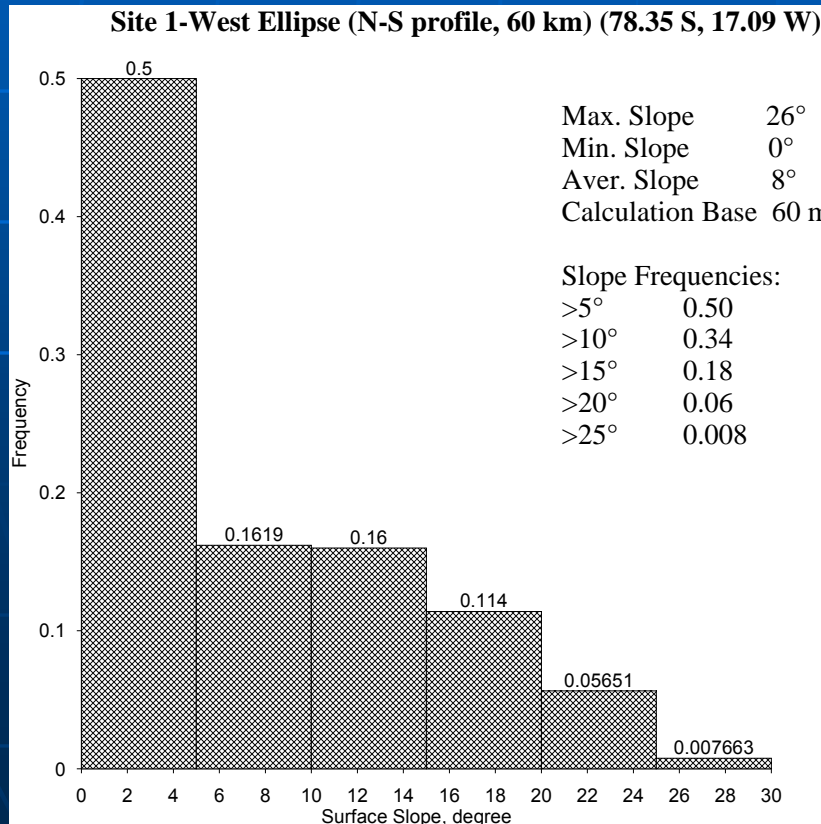
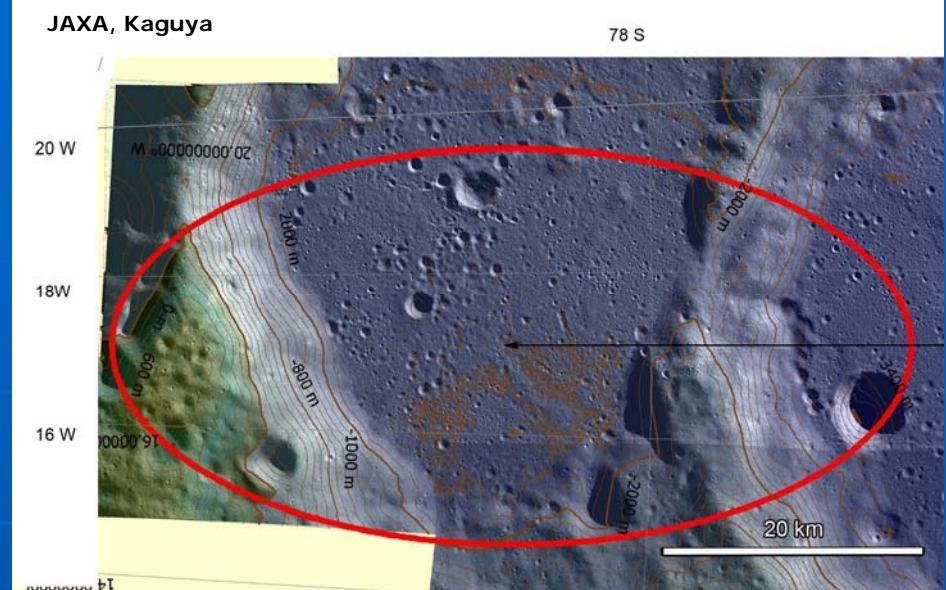


The approaching track goes along highland terrain reaching the crater basins with steep slopes of rims.

Site 1-West Ellipse (60x30 km)

(78.35 S, 17.09 W)

Altitude Range	4285 m
Average Slope	8 deg.
Max. Slope	26 deg.
Slope >15 deg, (60 m base)	18 %



- Basin Terrain with high altitude range (4 km) due to steep rim slopes

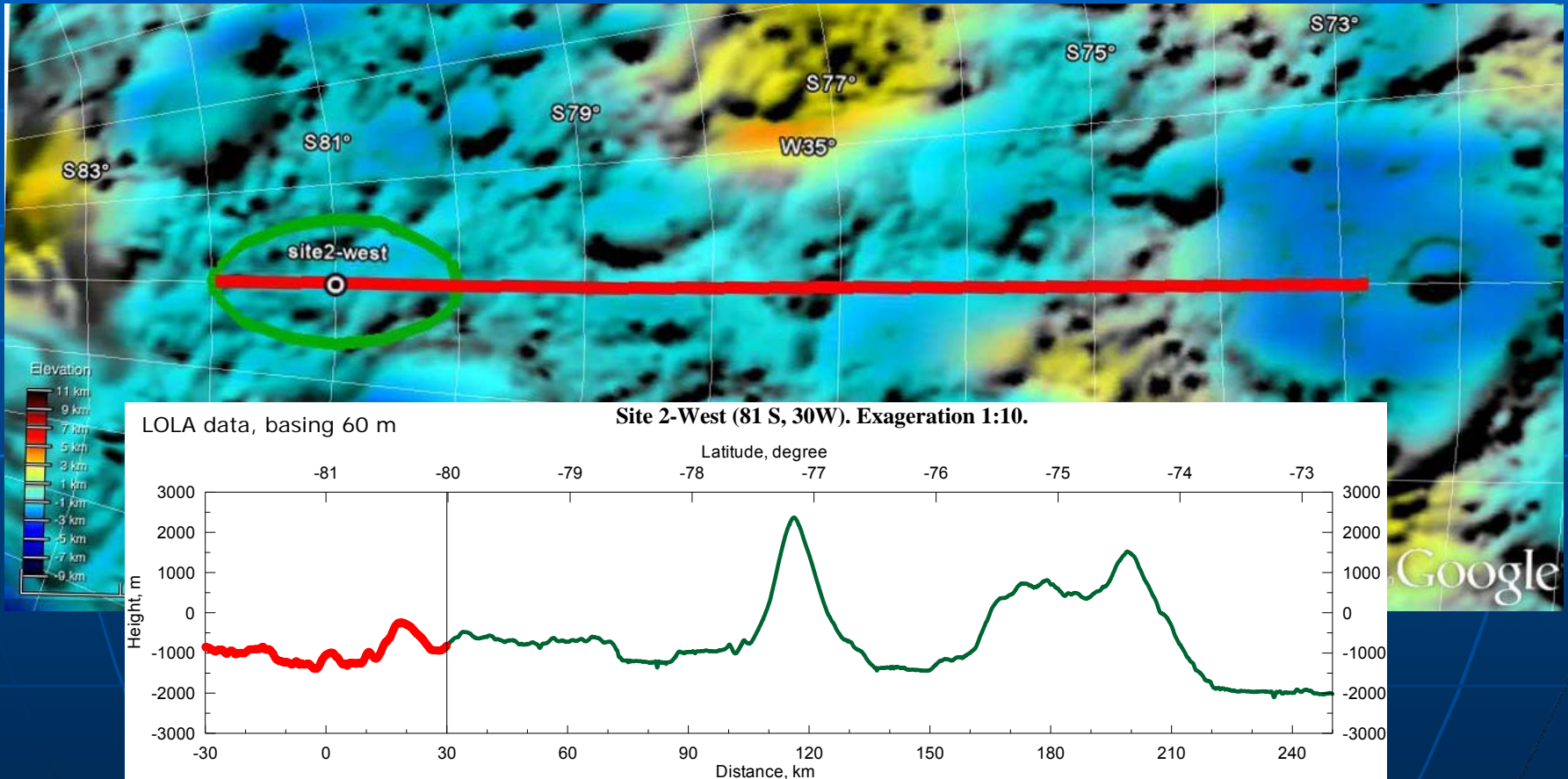
Our Estimation:
Landing is risky for such ellipse size!

Site 2-West (80.99 S, 29.98 W)

280-km Approach Track

Rough highland terrain and crater bassins

Altitude Range	4473 m
Average Slope	6 deg.
Max. Slope	32 deg.
Slope >15 deg	7 %

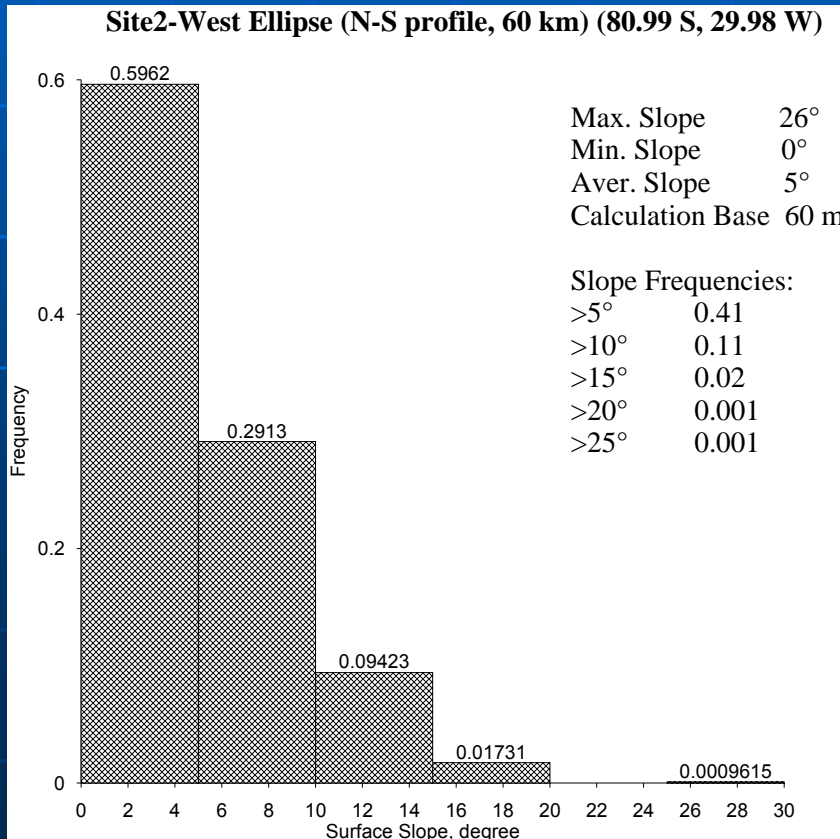
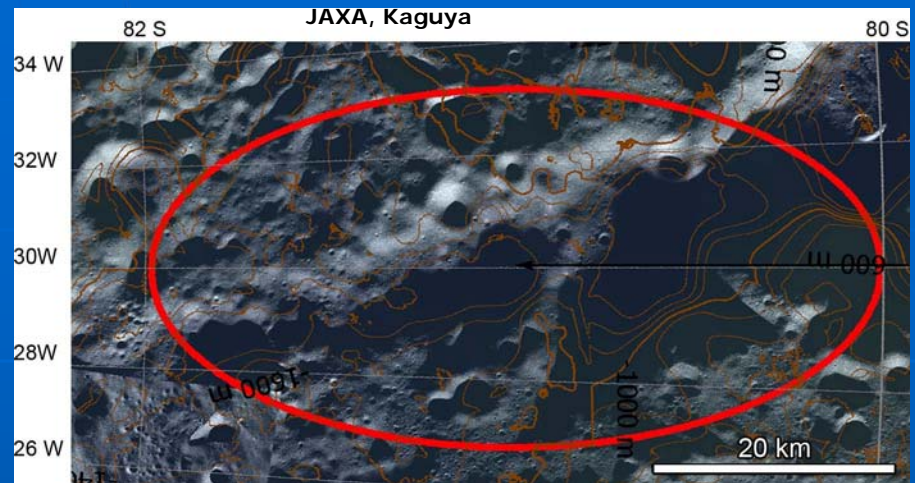


The approaching track goes through highland terrain crossing some bassin rim swells and reaching the relatively smooth highland surface.

Site 2-West Ellipse (60x30 km)

(80.99 S, 29.98 W)

Altitude Range	1144 m
Average Slope	5 deg.
Max. Slope	26 deg.
Slope >15 deg, (60 m base)	2 %



- + Relatively smooth highland terrain
- Small crater in the Northern Part
- High swell in the middle of approaching track

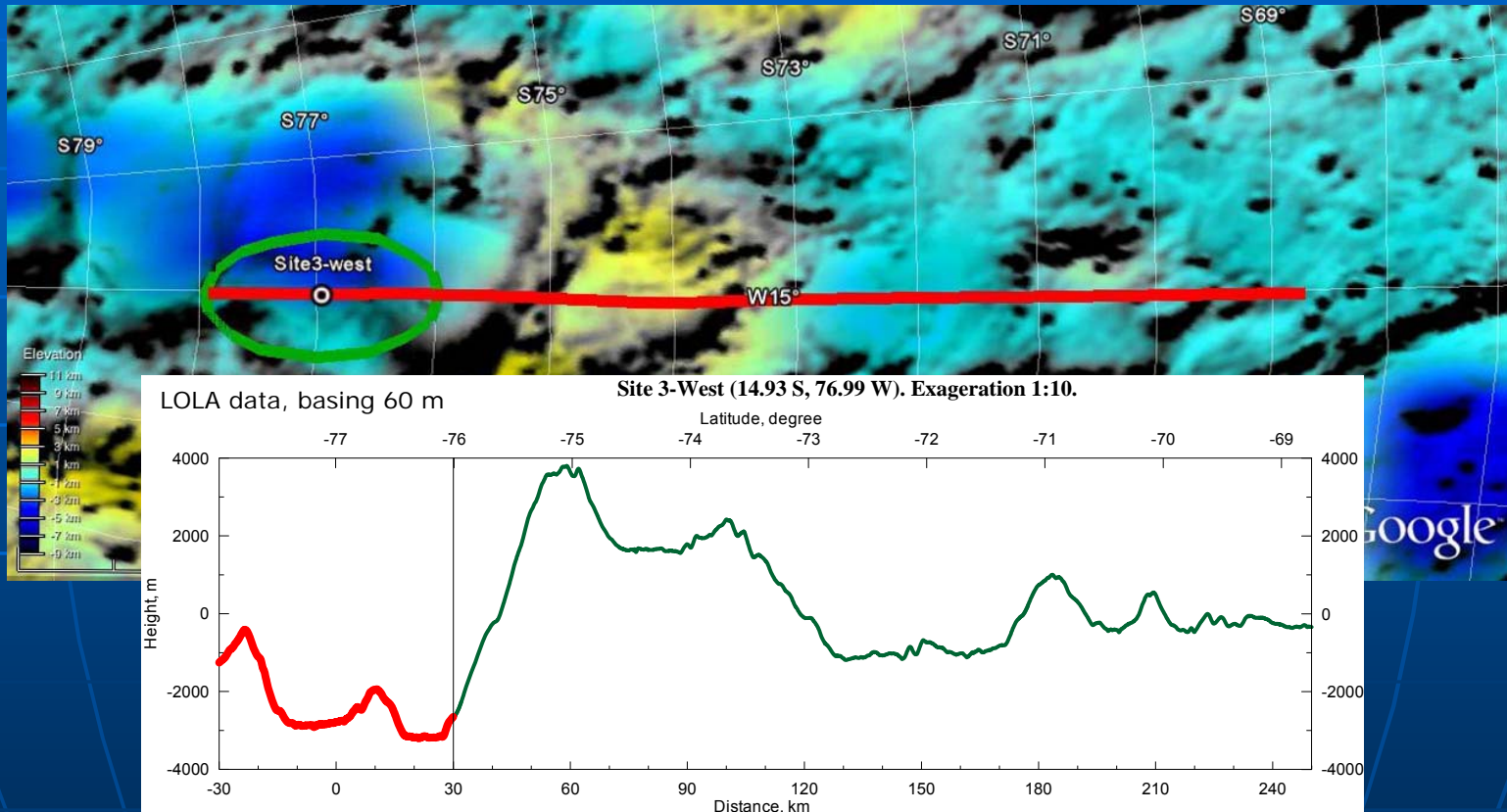
Our Estimation:
The site could be recommended for landing

Site 3-West (76.99 S, 14.93 W)

280-km Approach Track

Rough highland terrain and crater basins

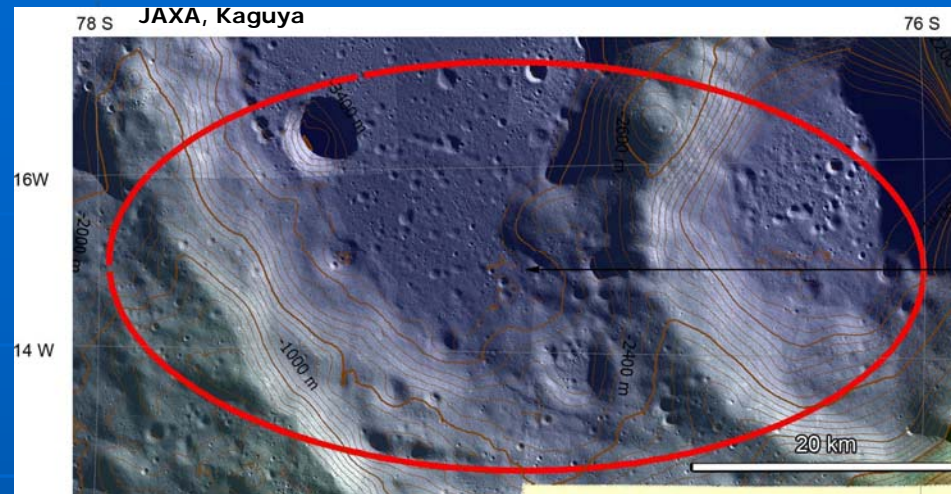
Altitude Range	7000 m
Average Slope	7 deg.
Max. Slope	30 deg.
Slope >15 deg	10 %



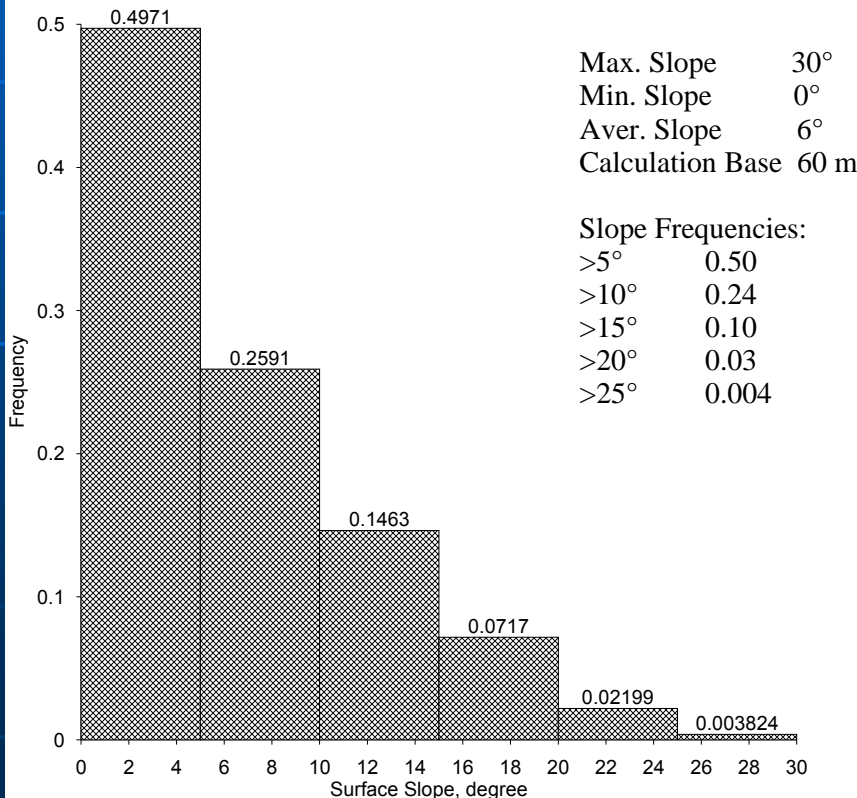
The approaching track goes along highland terrain crossing very steep N crater basing slope at the finish, reaching the crater basins with steep slopes of rims.

Site 3-West Ellipse (60x30 km) (76.99 S, 14.93 W)

Altitude Range	2788 m
Average Slope	6 deg.
Max. Slope	30 deg.
Slope >15 deg, (60 m base)	10 %



Site 3-West Ellipse (N-S profile, 60 km) (76.99 S, 14.93 W)



- Basin Terrain with high altitude range (3 km) with steep rim slopes

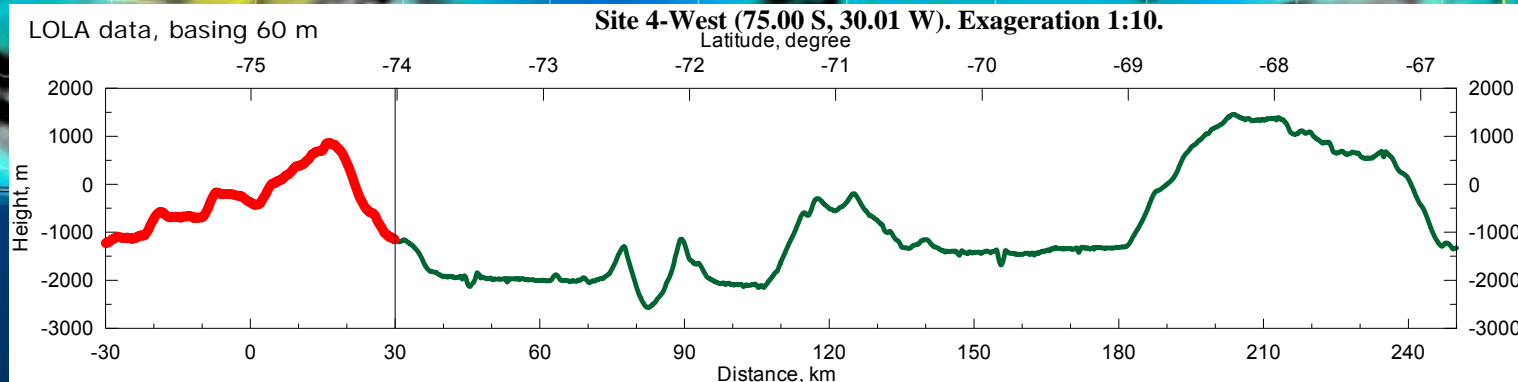
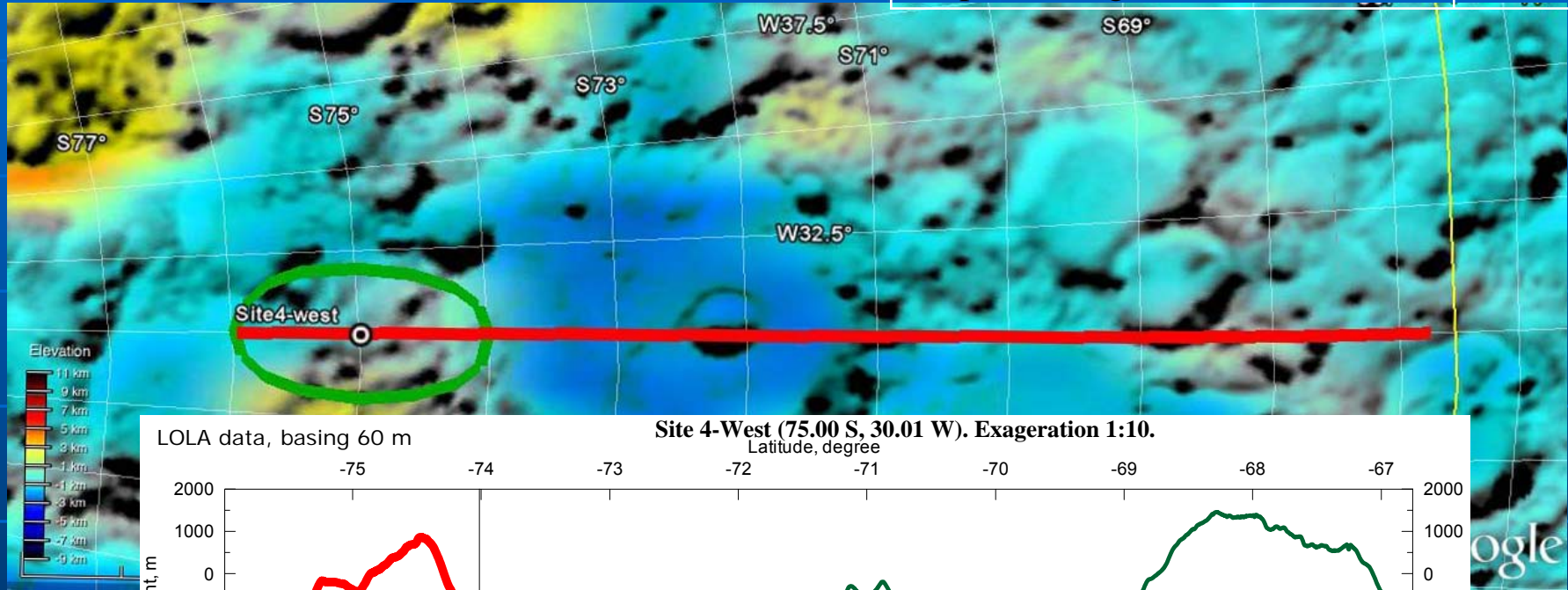
**Our Estimation:
Landing is too risky!**

Site 4-West (75.00 S, 30.01 W)

280-km Approach Track

Rough highland terrain and crater basins

Altitude Range	4027 m
Average Slope	6 deg.
Max. Slope	29 deg.
Slope >15 deg	5 %

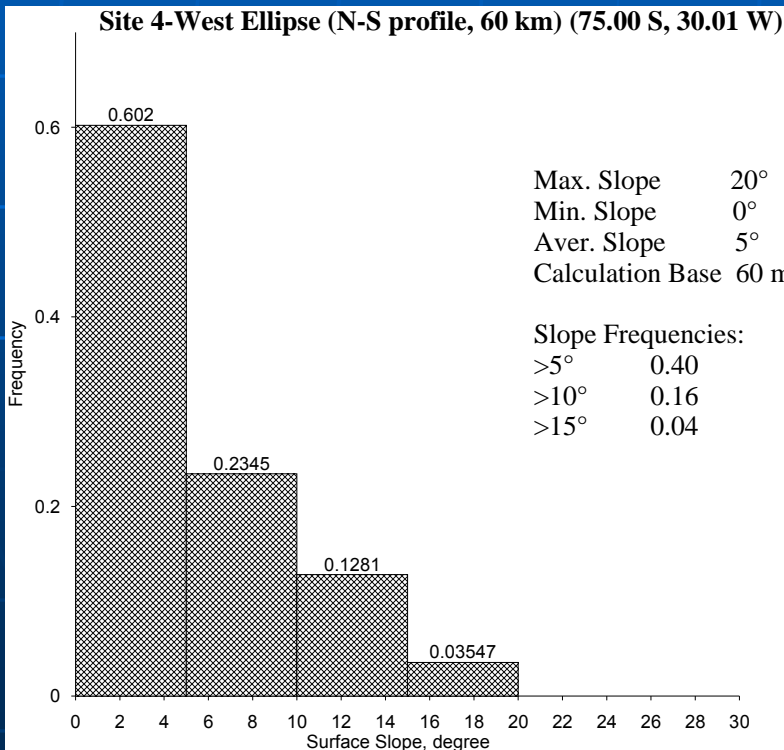
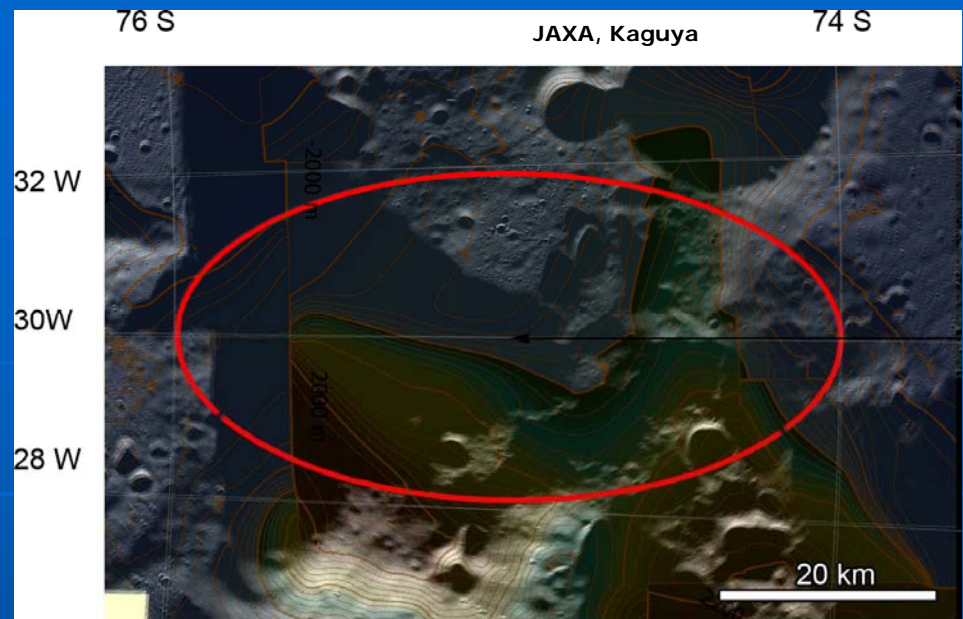


The approaching track goes along highland terrain and crater basins reaching the steep crater basin S slope and rough highland terrain with opposite slopes.

Site 4-West Ellipse (60x30 km)

(75.00 S, 30.01 W)

Altitude Range	2118 m
Average Slope	5 deg.
Max. Slope	20 deg.
Slope >15 deg, (60 m base)	4 %



- + Relatively Less Rough Highland Terrain
- Opposite gentle S slopes along ellipse
- Steep basin N slope in the N part

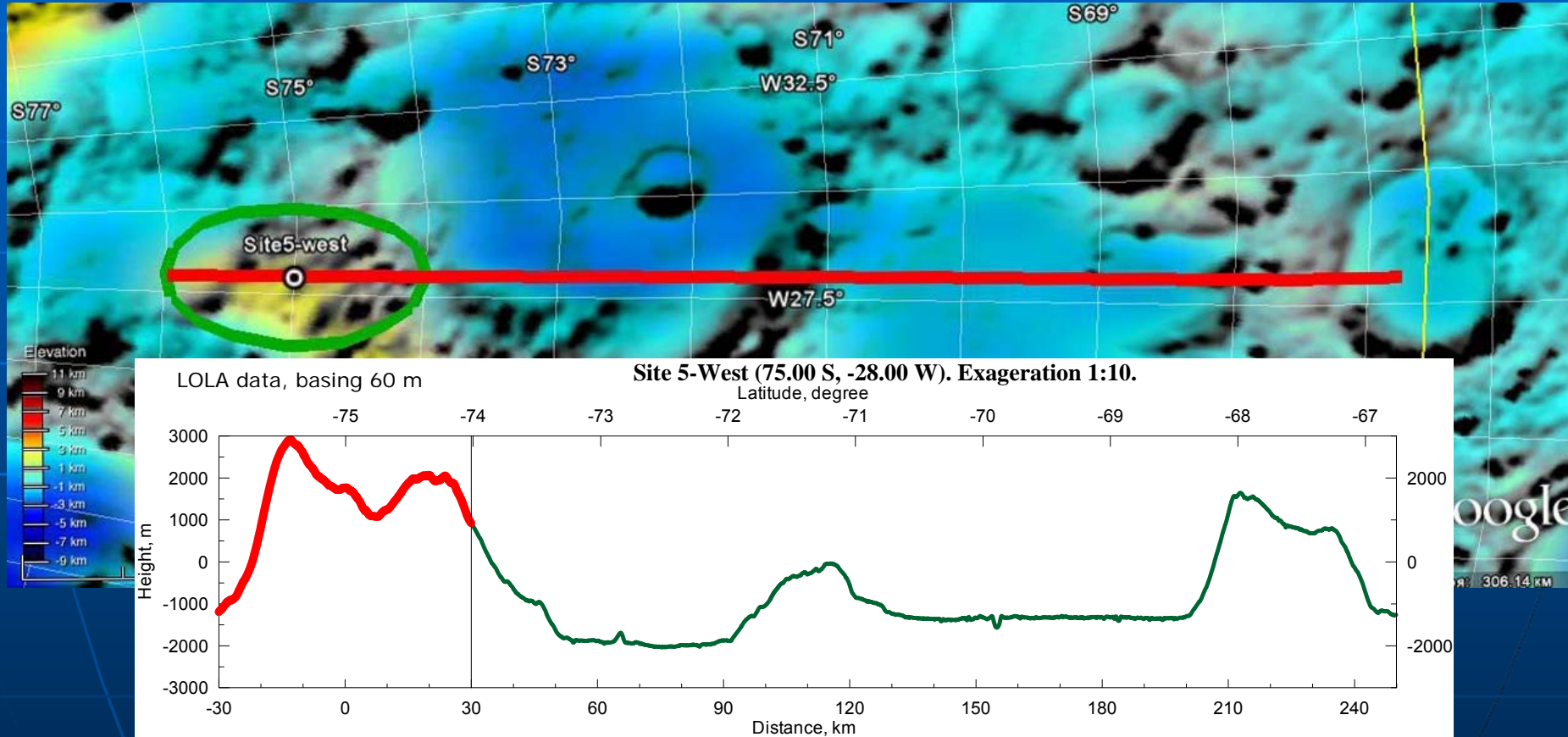
Our Estimation:
Landing is risky!

Site 5-West (75 S, 28 W)

280-km Approach Track

Rough highland terrain and crater basins

Altitude Range	4945 m
Average Slope	6 deg.
Max. Slope	27 deg.
Slope >15 deg	7 %

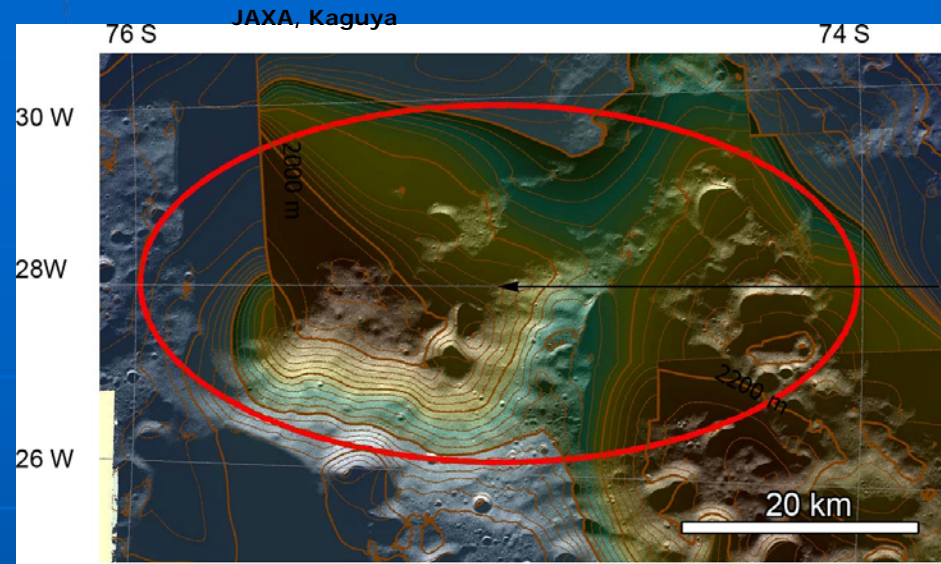


The approaching track goes along crater basins reaching the highly rough highland terrain with altitude range >4 km.

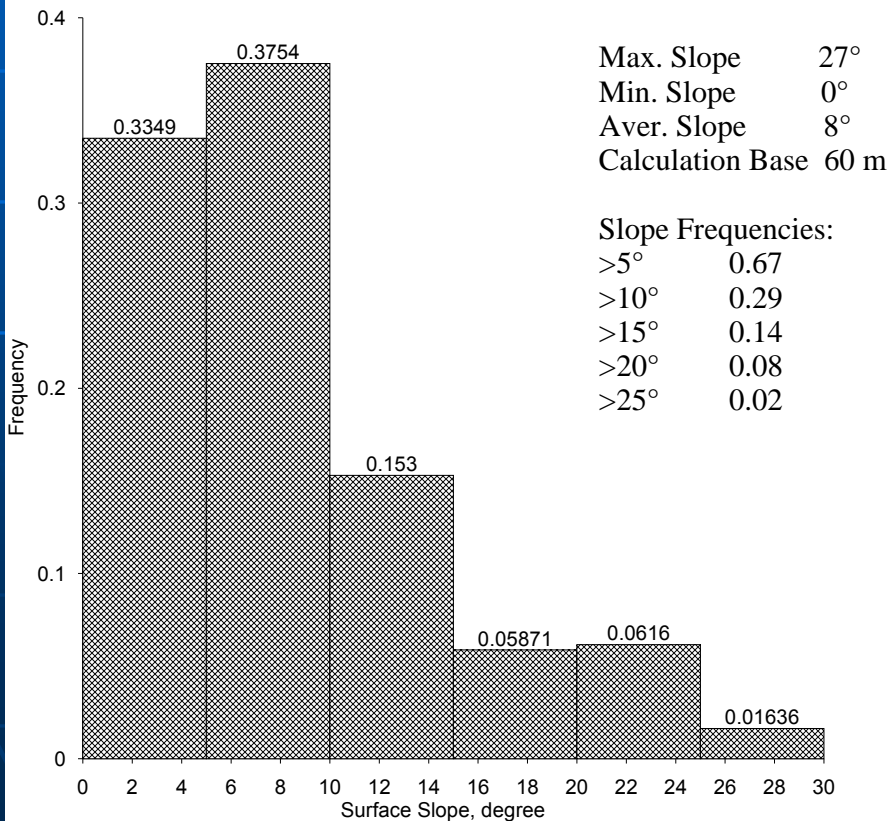
Site 5-West Ellipse (60x30 km)

(75 S, 28 W)

Altitude Range	4139 m
Average Slope	8 deg.
Max. Slope	27 deg.
Slope >15 deg, (60 m base)	14 %



Site 5-West Ellipse (N-S profile, 60 km) (75.00 S, 28.00 W)



- Very Rough highland terrain within ellipse with high altitude range

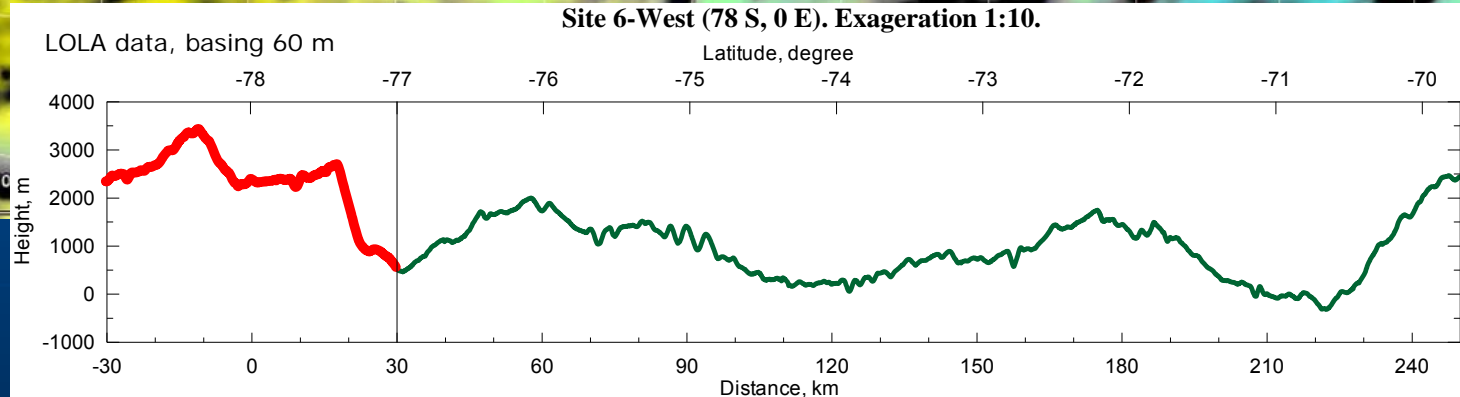
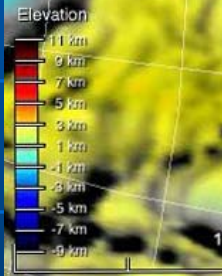
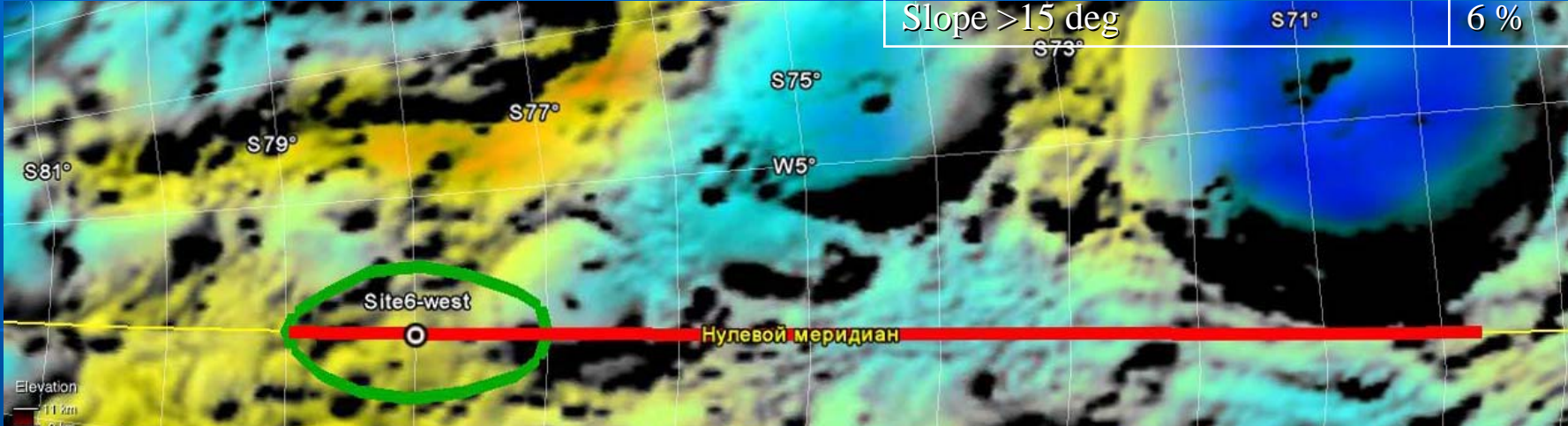
Our Estimation:
Landing is too risky!

Site 6-West (78 S, 0 E)

280-km Approach Track

Moderately Rough highland terrain

Altitude Range	3756 m
Average Slope	6 deg.
Max. Slope	24 deg.
Slope >15 deg	6 %

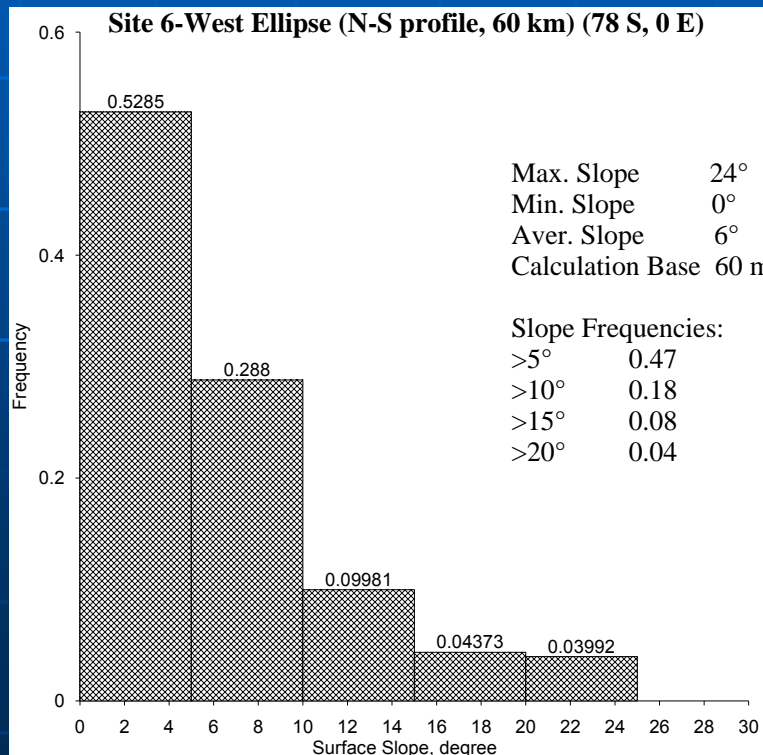
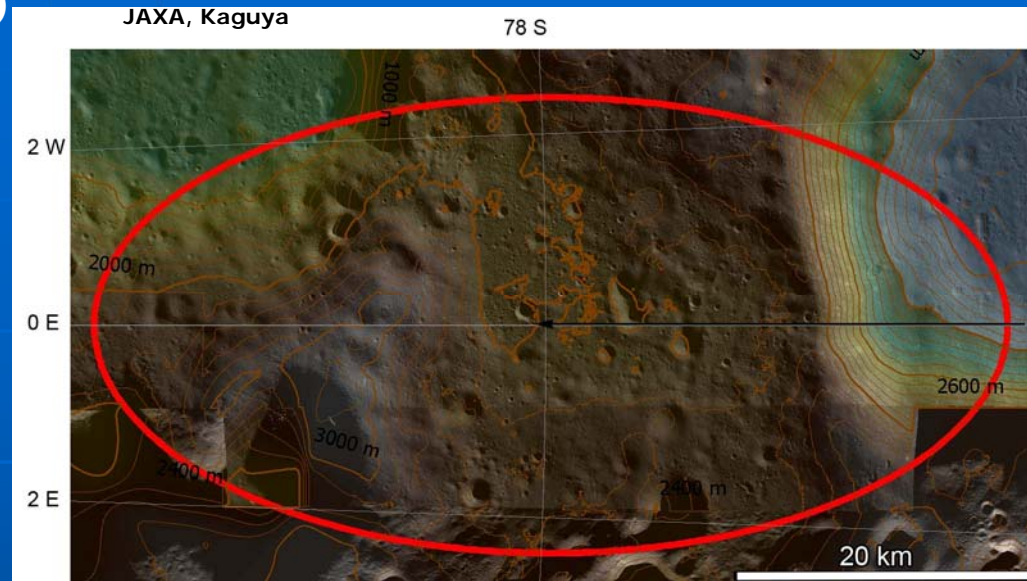


The approach track goes along moderately rough highland terrain reaching S steep basing slope and then moderately smooth highland terrain.

Site 6-West Ellipse (60x30 km)

(78 S, 0 E)

Altitude Range	2901 m
Average Slope	6 deg.
Max. Slope	24 deg.
Slope >15 deg, (60 m base)	8 %



- + Relatively Less Rough Highland Terrain
- Opposite gentle S slopes along ellipse
- Steep basin N slope in the N part

Our Recommendation: to shift the site to S to escape the slope and less the altitude range within ellipse

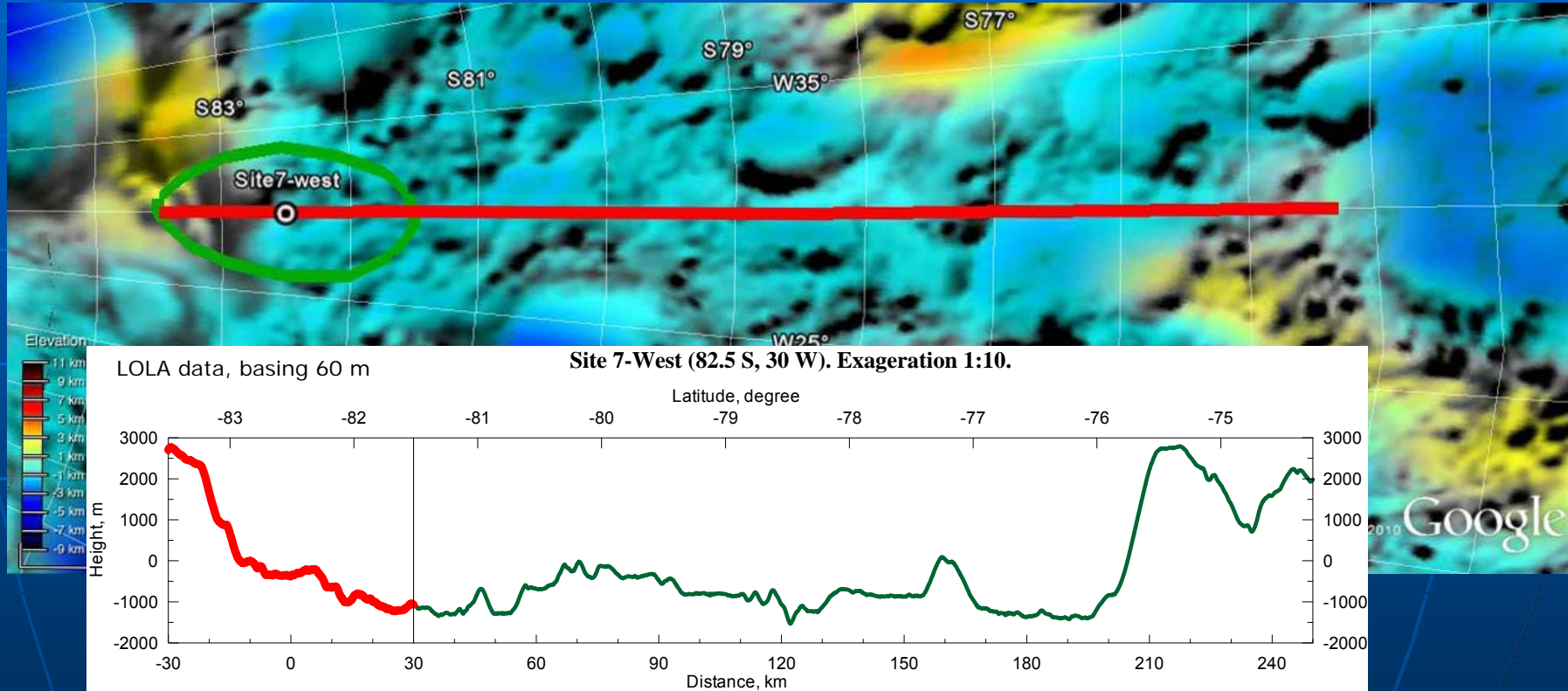
Our Estimation:
Landing is reserved!

Site 7-West (82.5 S, 30.0 W)

280-km Approach Track

- + Moderately rough highland terrain
- Steep S slope at the finish

Altitude Range	4327 m
Average Slope	6 deg.
Max. Slope	28 deg.
Slope >15 deg	7 %



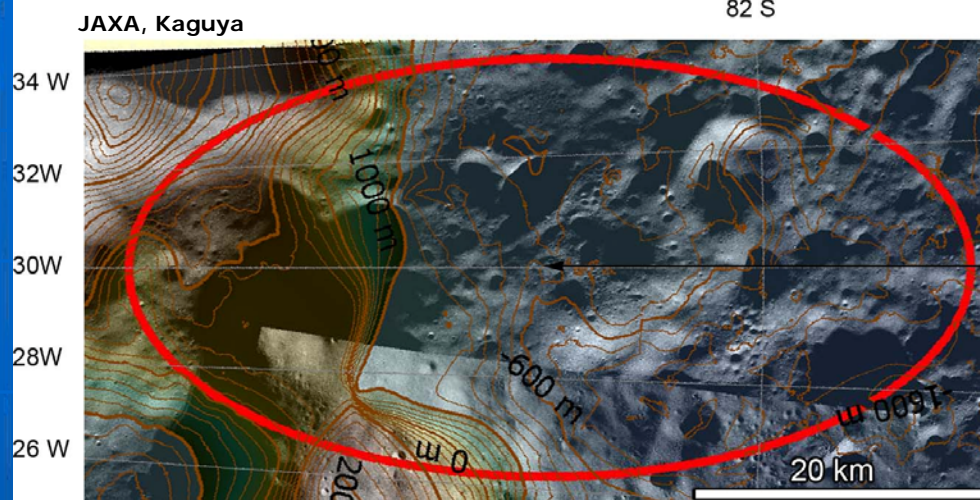
2010 Google

The approach track goes along moderately rough highland terrain reaching highland terrain place with highly steep S slopes at the end.

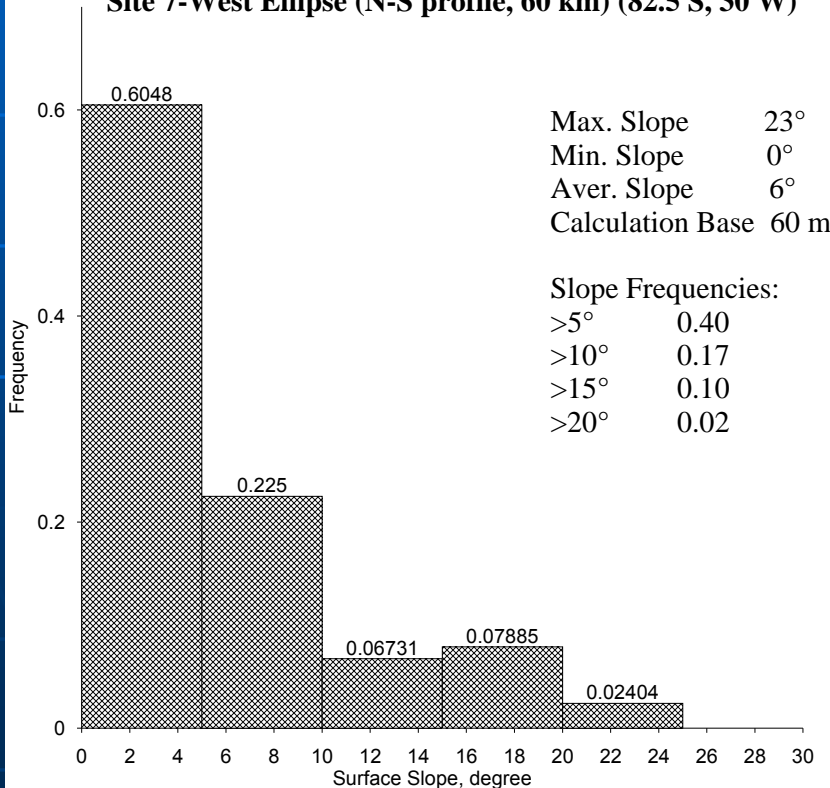
Site 7-West Ellipse (60x30 km)

(82.5 S, 30.0 W)

Altitude Range	3999 m
Average Slope	6 deg.
Max. Slope	23 deg.
Slope >15 deg, (60 m base)	10 %



Site 7-West Ellipse (N-S profile, 60 km) (82.5 S, 30 W)



- + Relatively Less Rough Highland Terrain in the N part
- Very Steep slope in the S ellipse part with altitude range 4 km

Our Recommendation: to shift the site to N to more moderately rough highland terrain

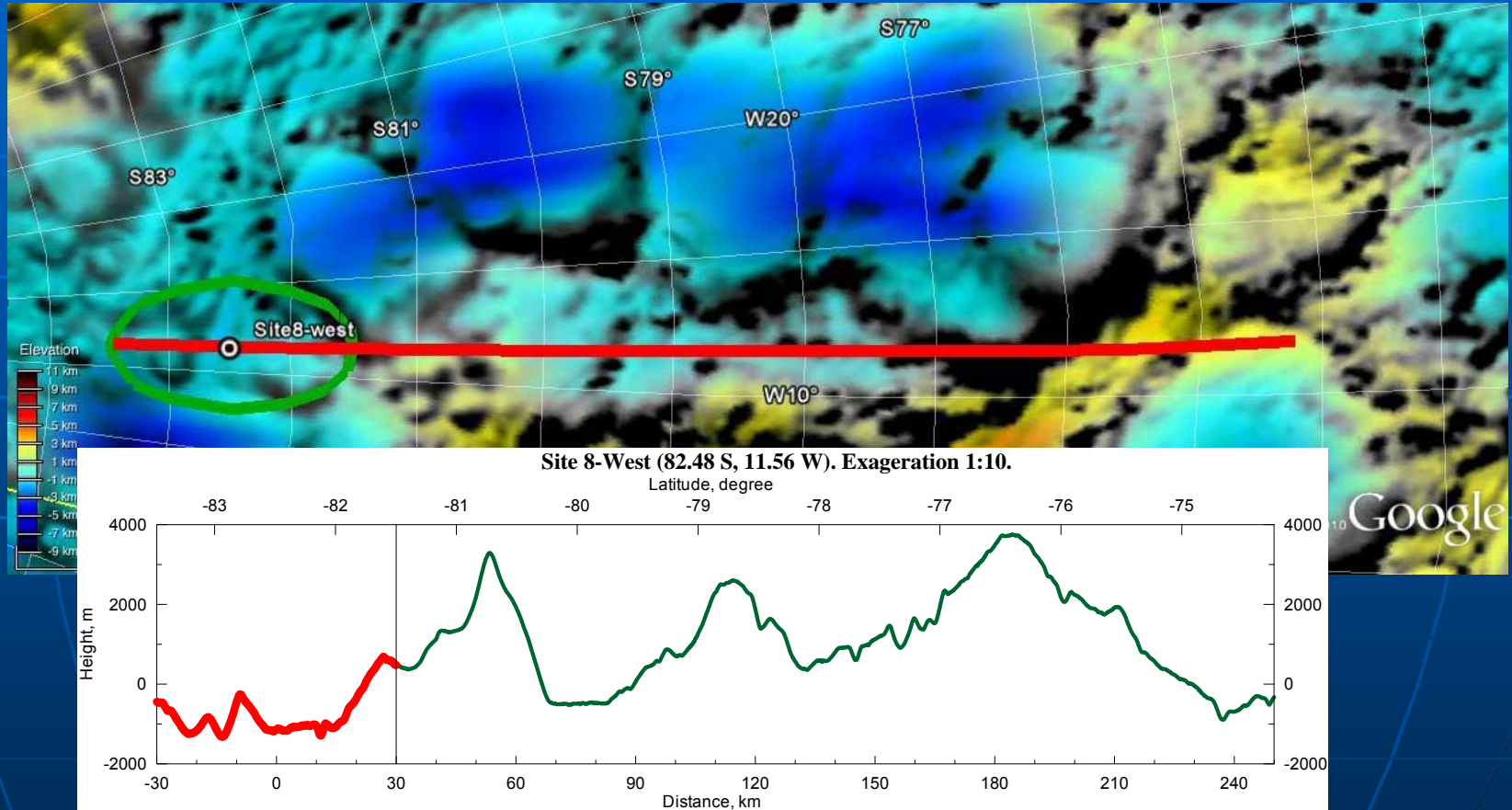
Our Estimation:
Landing is reserved!

Site 8-West (82.48 S, 11.56 W)

280-km Approach Track

- High Altitude Range of highly rough highland terrain

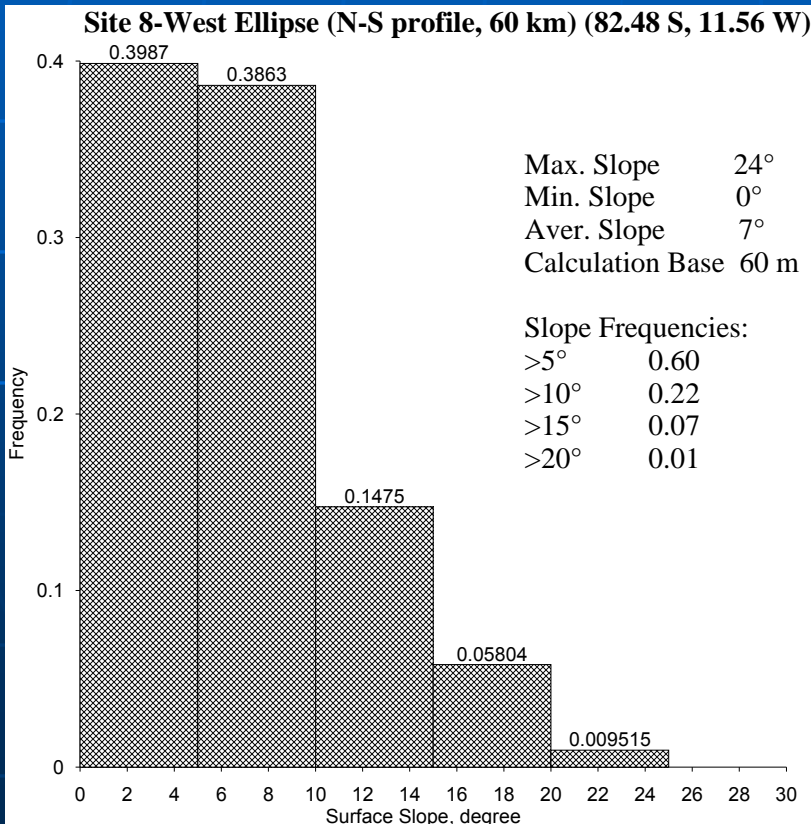
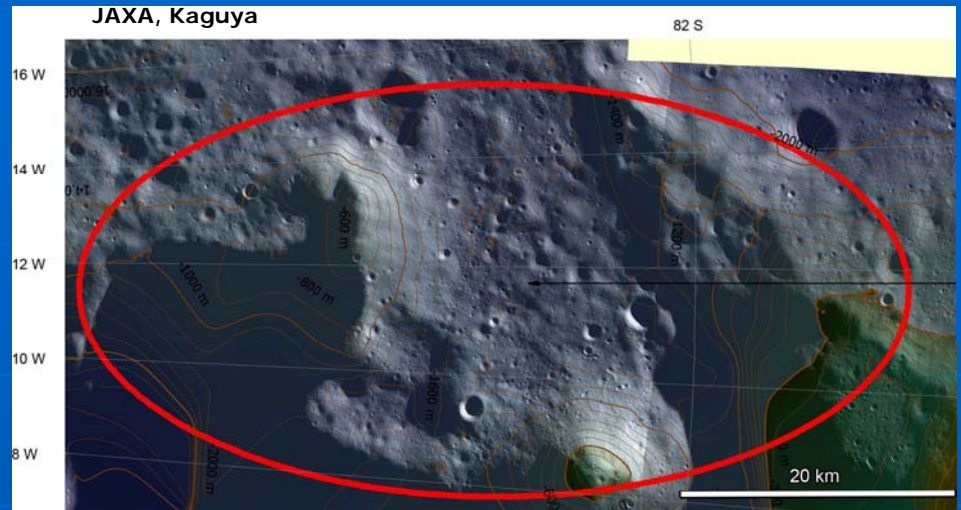
Altitude Range	5083 m
Average Slope	7 deg.
Max. Slope	26 deg.
Slope >15 deg	10 %



The approach track goes along very rough highland terrain with several peaks and altitude range ~5 km.

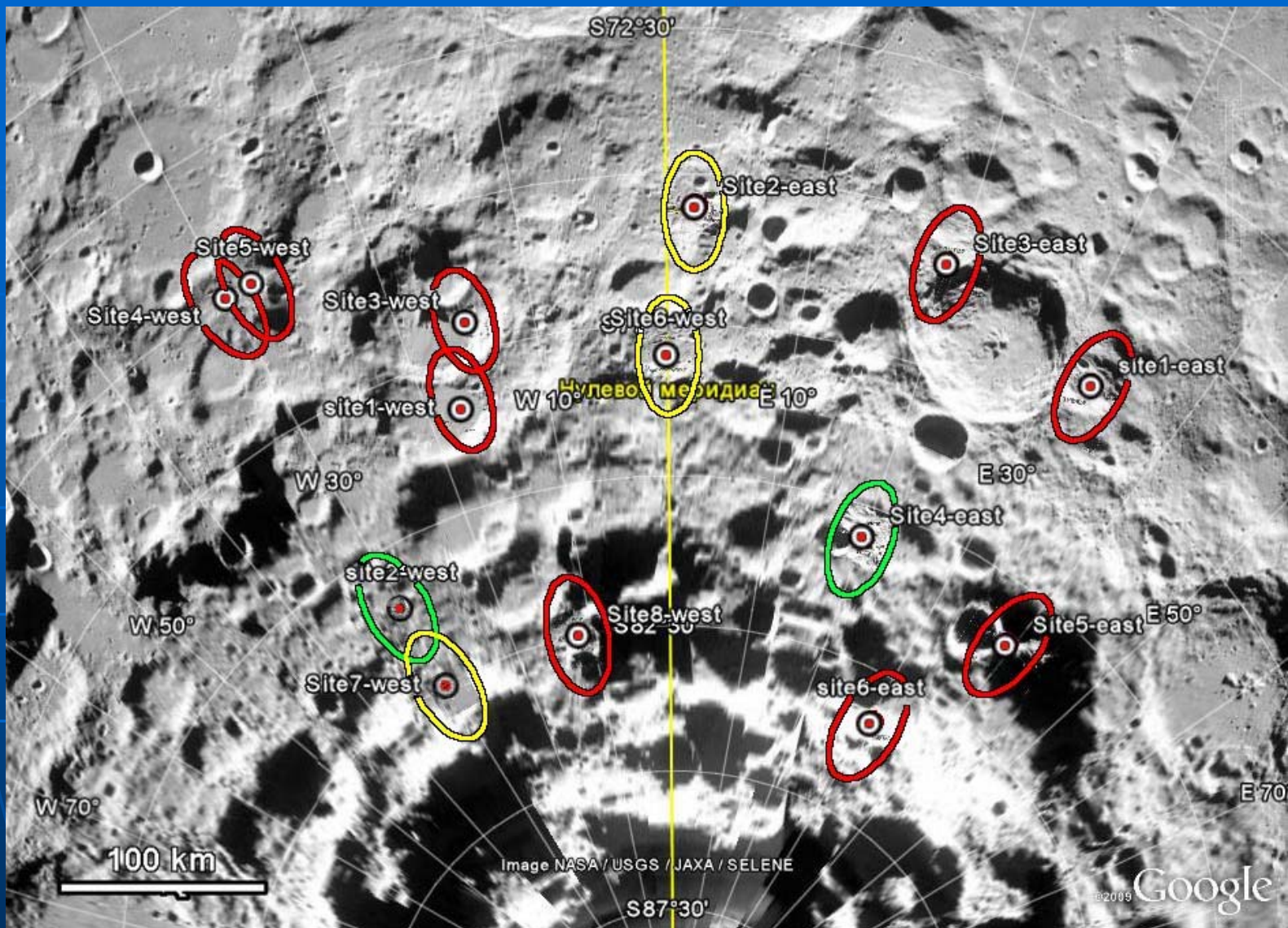
Site 8-West Ellipse (60x30 km) (82.48 S, 11.56 W)

Altitude Range	2014 m
Average Slope	7 deg.
Max. Slope	24 deg.
Slope >15 deg, (60 m base)	7 %

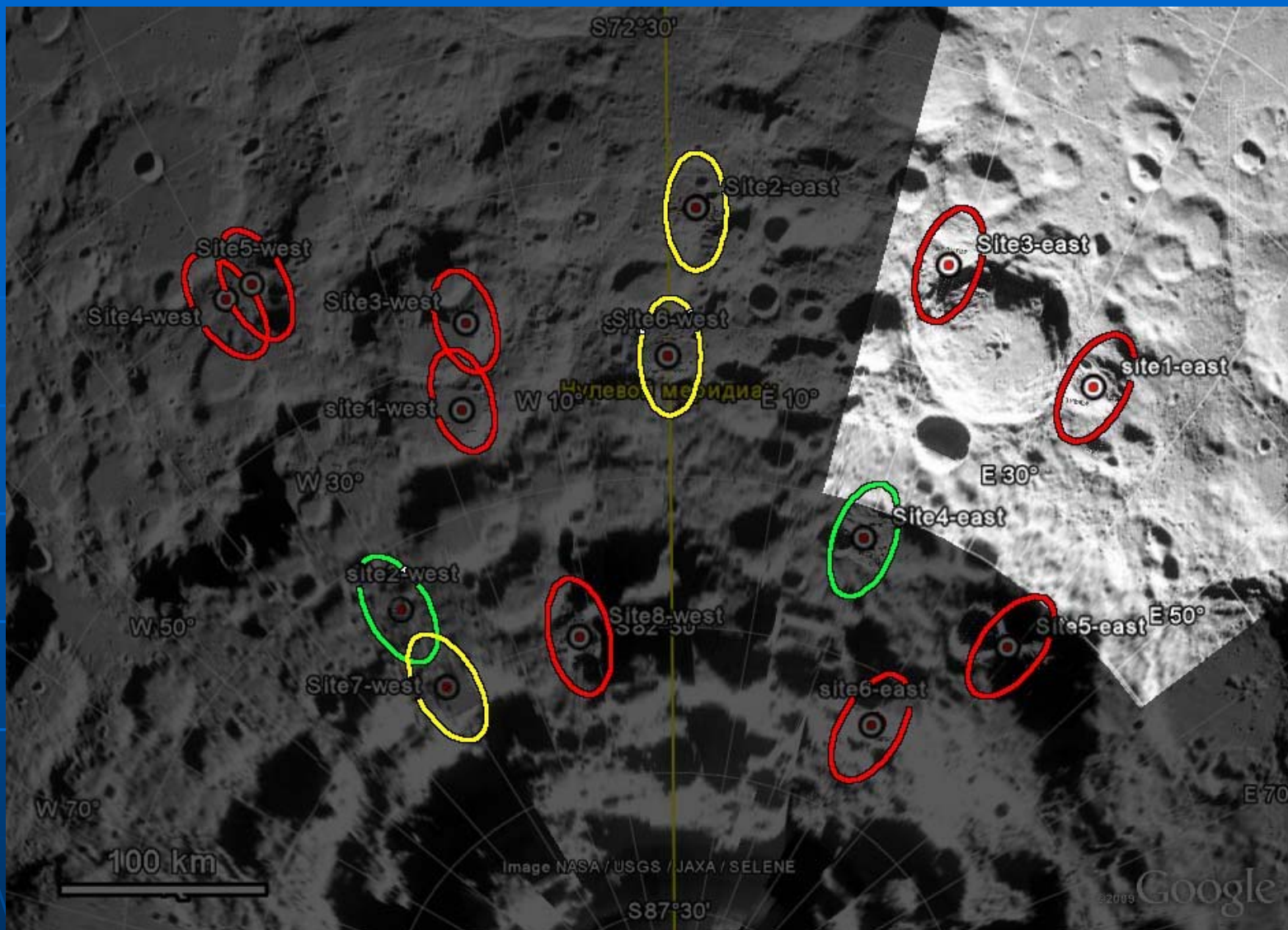


- Rough highland terrain within ellipse
- The approach track crossing 3 peaks with high altitude range

Our Estimation:
Landing is too risky!



Our analyses show Site 2-West, and to a lesser extent Site 4-East are most preferable by risk conditions. Site2-East, Site6-West и Site7-West are reserved, but they should be moved by several km.



According to new Lavochkin SPA Conditions: landing window is 80 E, 15-55 E. Only N part of preferable Site 4 East ellipse crosses the landing window. It is possible to fit in the window if we resize to 30x15 km landing ellipse and shift them by several km – IT NEEDS FURTHER INVESTIGATION

Conclusions:

- **Site 2-West** (-80.99, -29.98), and to a lesser extent **Site 4-East** (-80.48, 19.86) are the most useful and secure places among 14 proposed landing sites .
- Site2-East (-75.539, 1.973588), Site6-West (-78.00, 0.00) и Site7-West (-82.5, -30) are reserved, but they should be moved by several km.