COMPOSITION AND ORIGIN OF THE LUNAR HIGHLAND CRUST

Paul D. Lowman Jr.

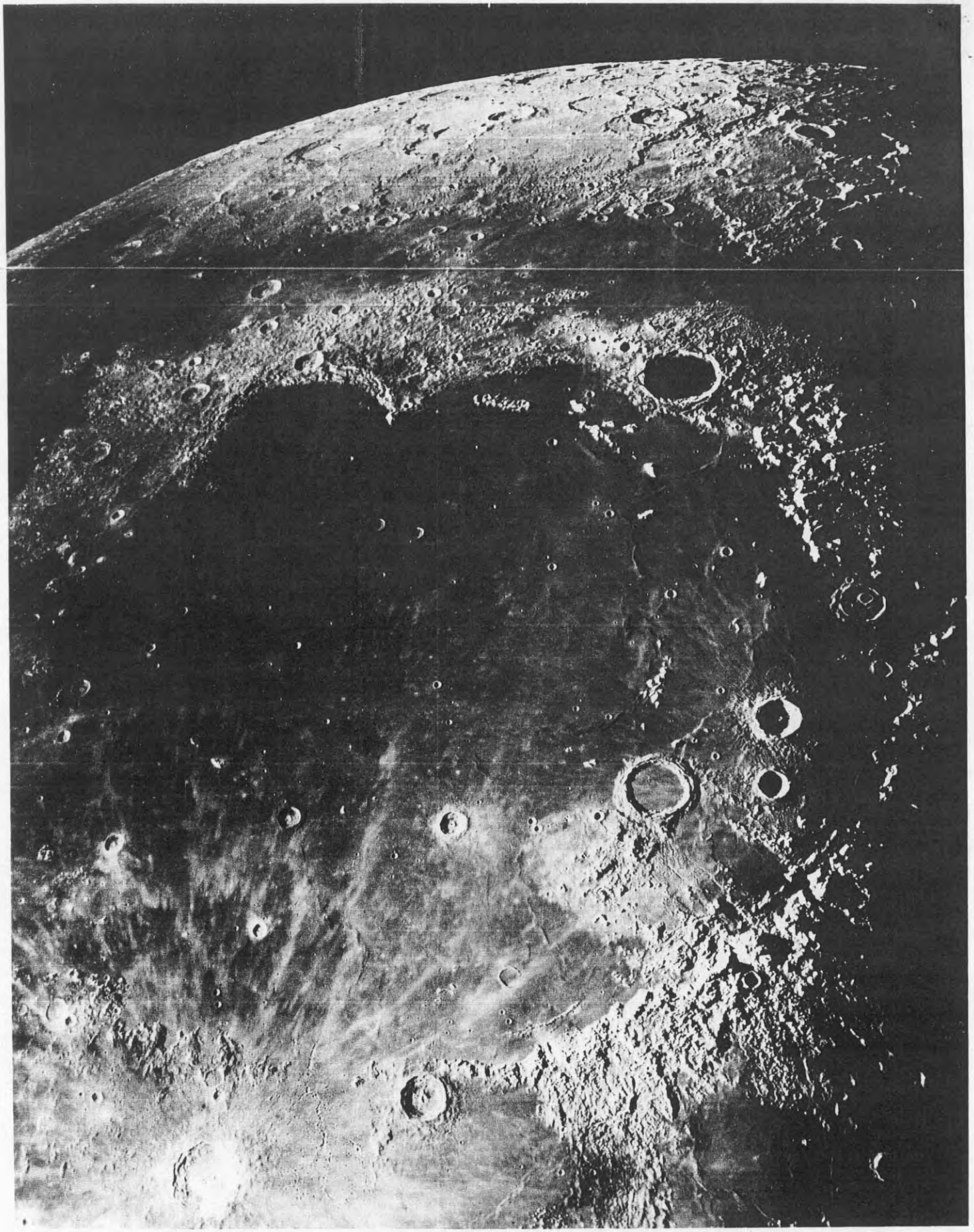
Goddard Space Flight Center

LINES OF EVIDENCE

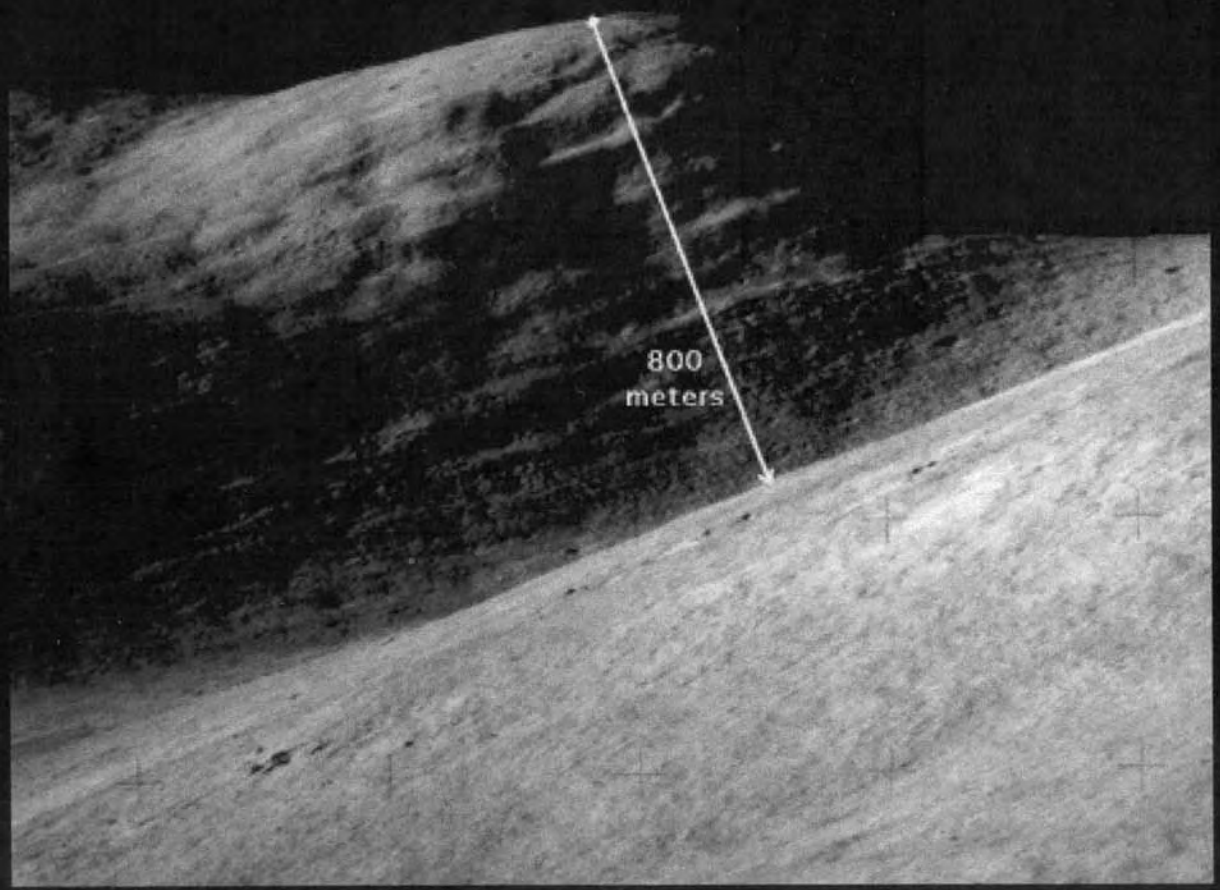
- Layered structure in highland crust
- Remote sensing data:

  X-ray fluorescence, gamma ray spectroscopy, reflectance spectroscopy
- Analytical data:

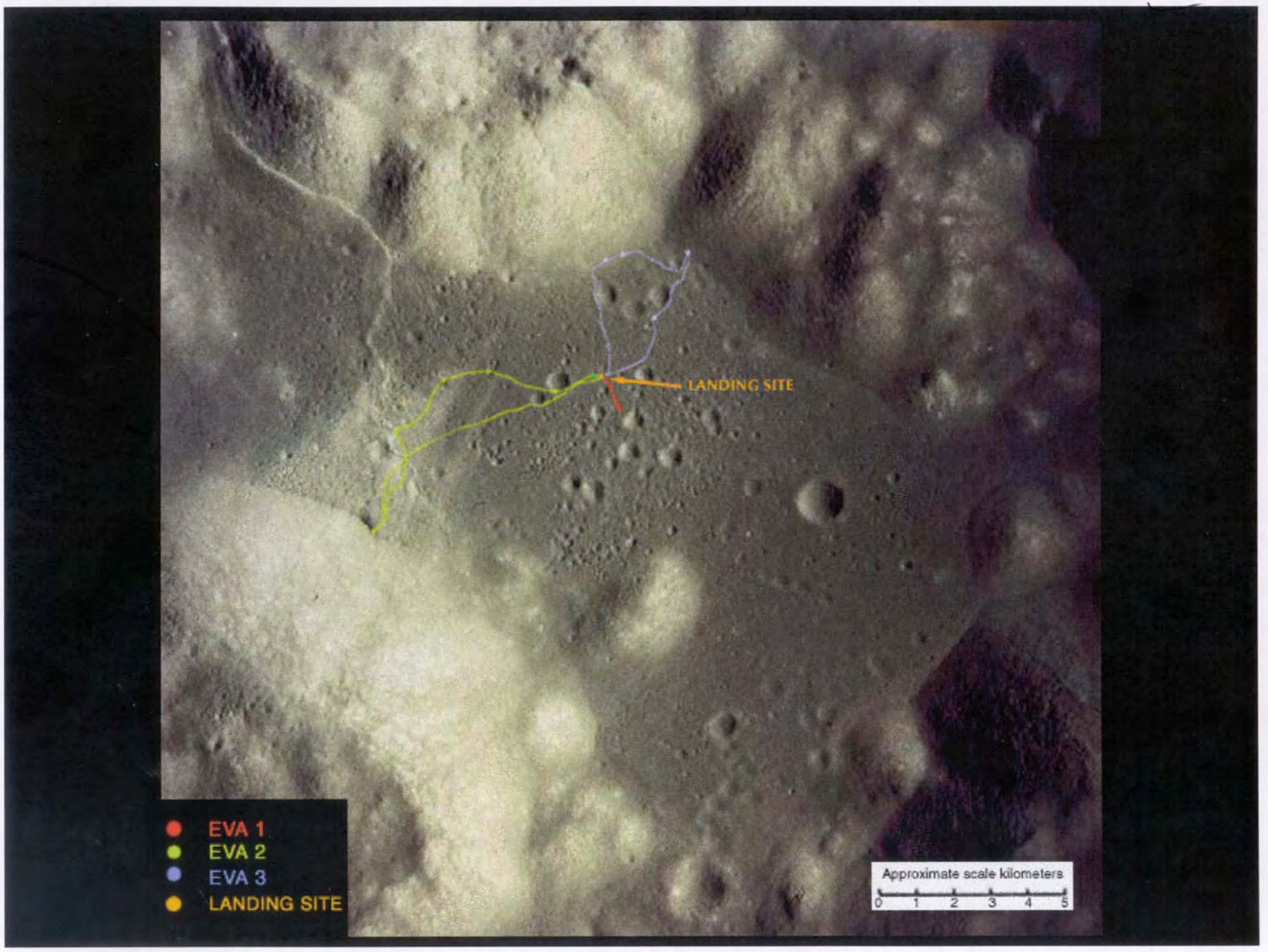
  returned sample analyses, lunar meteorites, robotic mission in situ analyses (Surveyor)



8

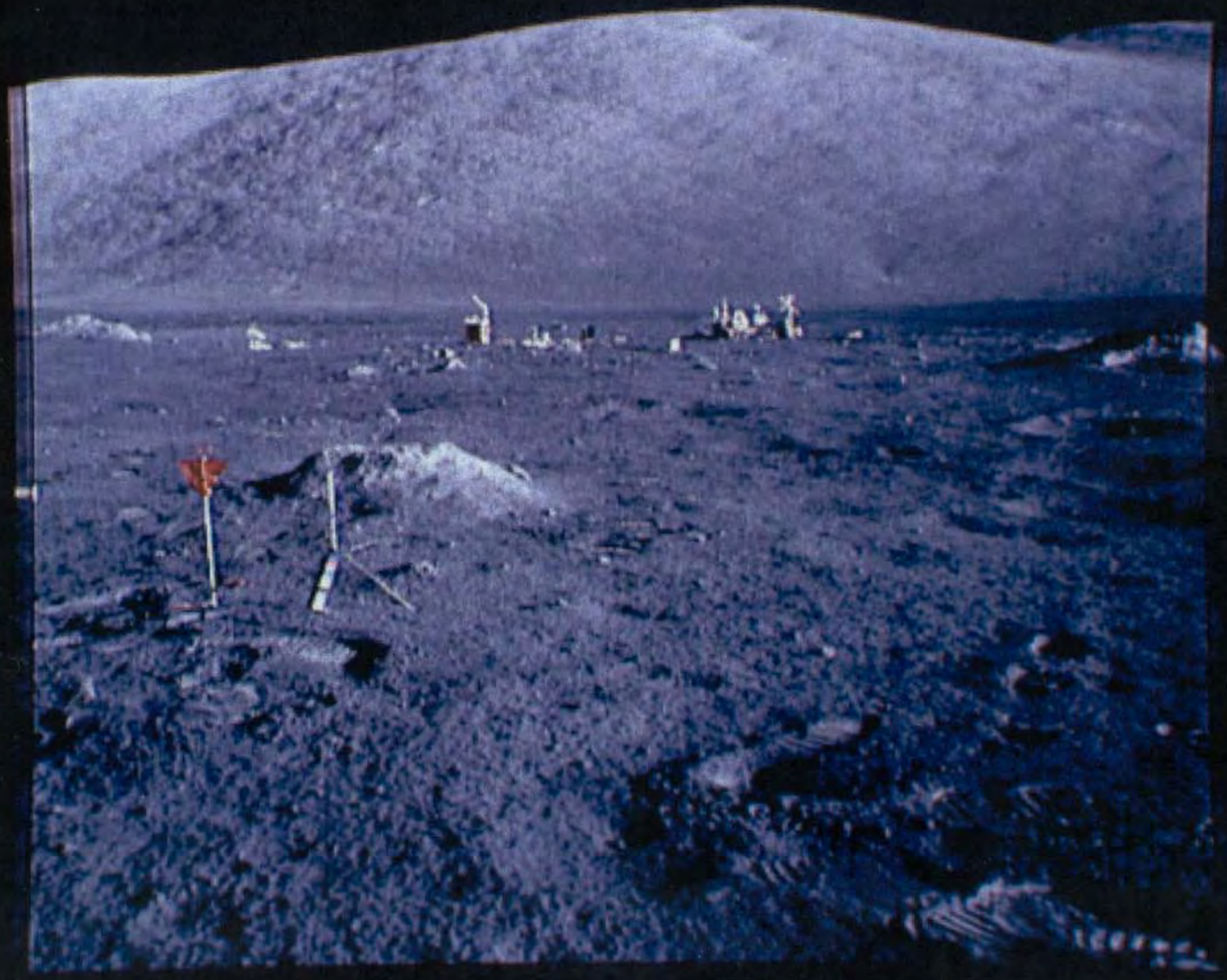


9


LANDING SITE
EVA 1
EVA 2
EVA 3
LANDING SITE
Approximate scale kilometers
0 1 2 3 4 5

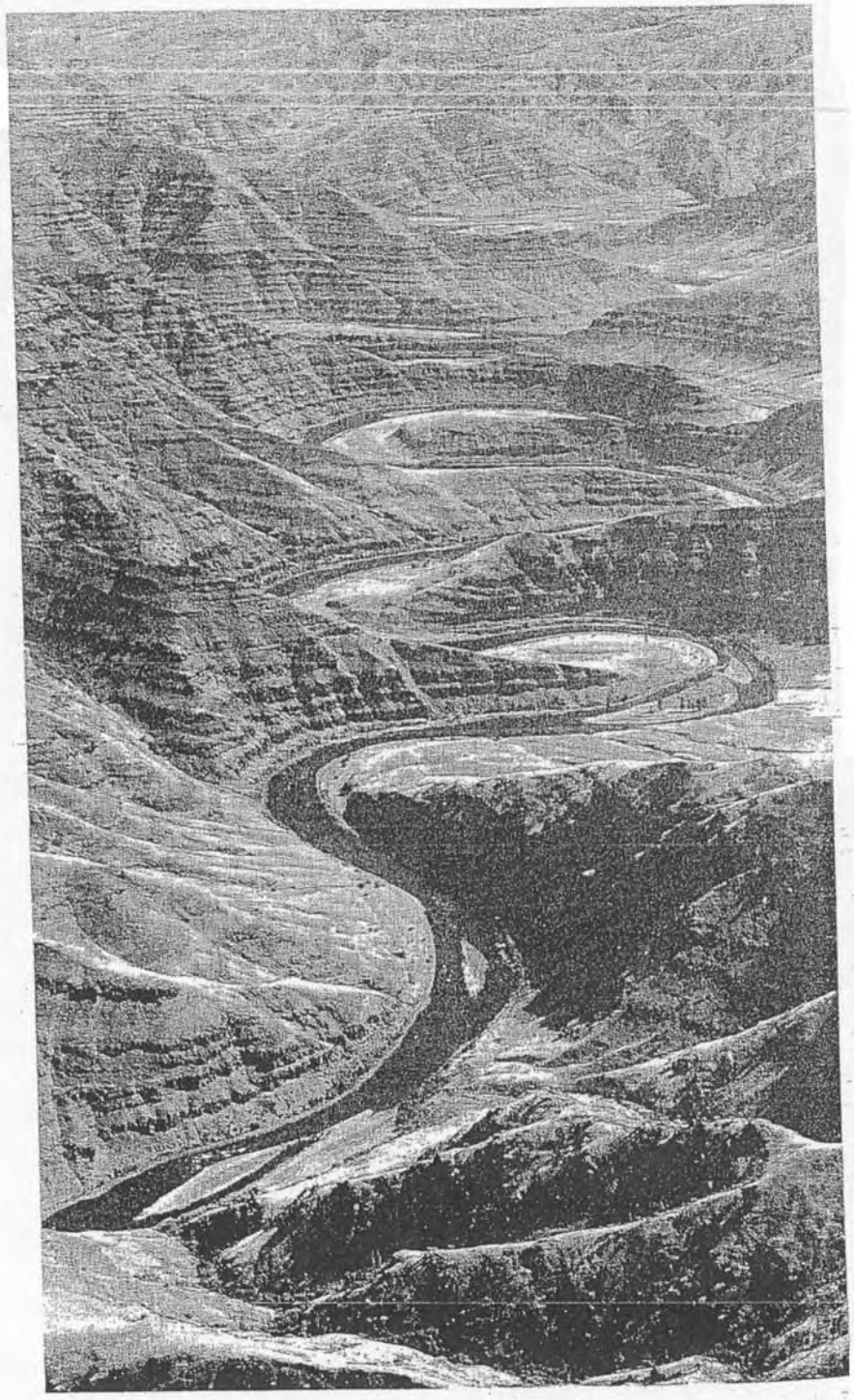
Sculptured Hills

11 Massif

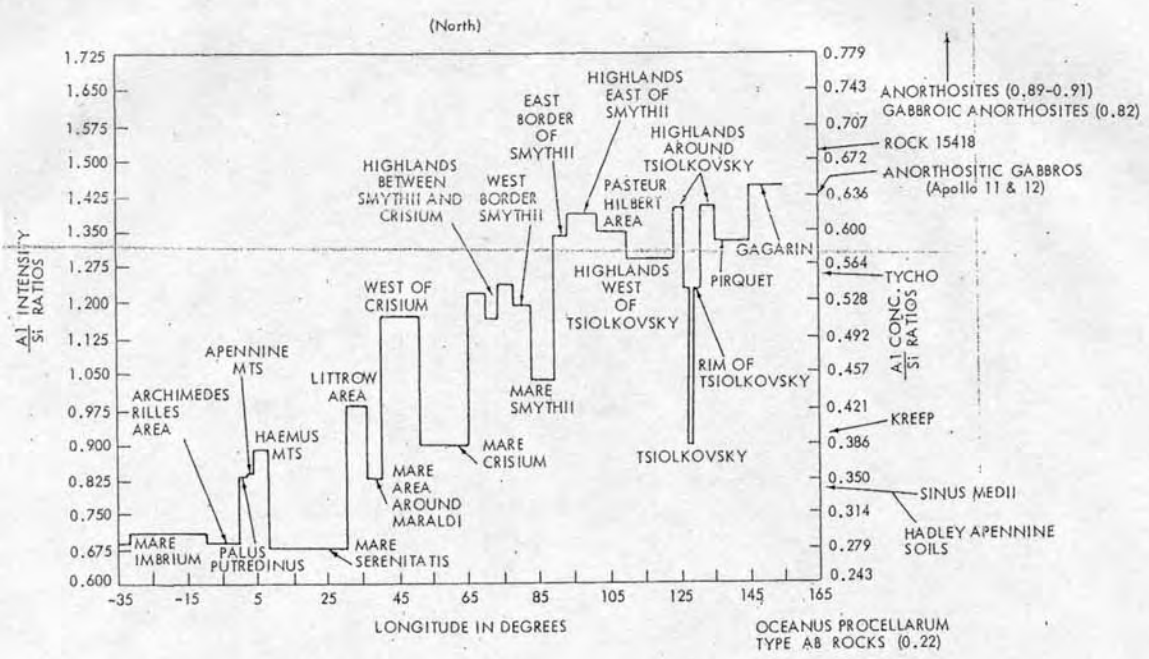


Results/ Conclusions

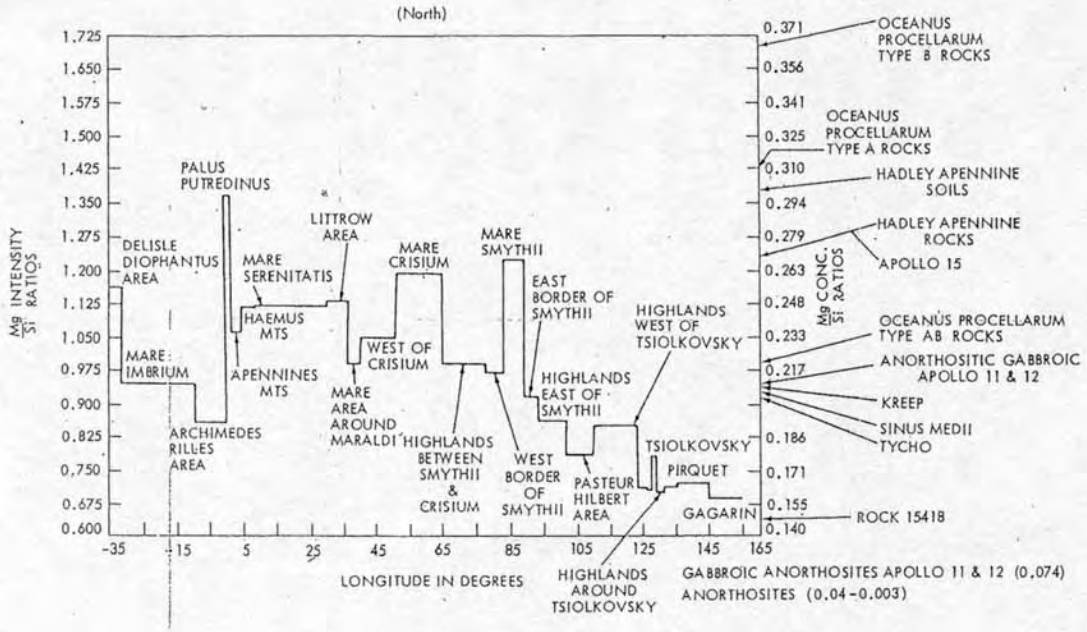
	Number of Traverses	Number of Layers	Average Thickness of layers (meters)
Silver Spur	4	42, 56, 52, 51	19, 14, 15, 16
St. George Crater	3	43, 40, 39	81, 88, 90
Sculptured Hills	2	21, 14	56, 84
North Massif	2	28, 23	44, 54



Columbia River Basalts: Grande Ronde River, Washington



Apollo 15 X-ray Fluorescence Data: Al/Si Ratios
(Yin et al., 1993)



Apollo 15 X-ray Fluorescence Data: Mg/Si Ratios
(Yin et al., 1993)

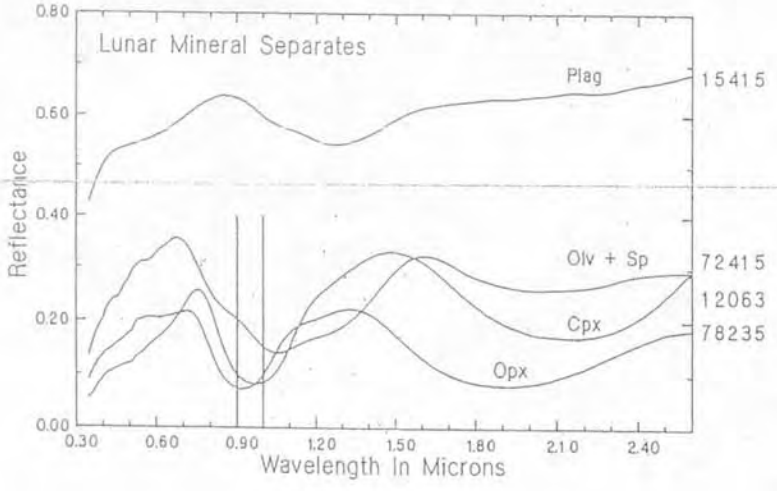


Fig. 14.1. Laboratory spectral reflectance measurements of lunar mineral separates. Plag = plagioclase feldspar; Olv + Sp = olivine with spinel; Cpx = clinopyroxene; Opx = orthopyroxene.

Laboratory Spectral Reflectance Measurements of Lunar Minerals (Plagioclase, Olivine, Spinel, Clinopyroxene, Orthopyroxene)

(Pieters, 1993)

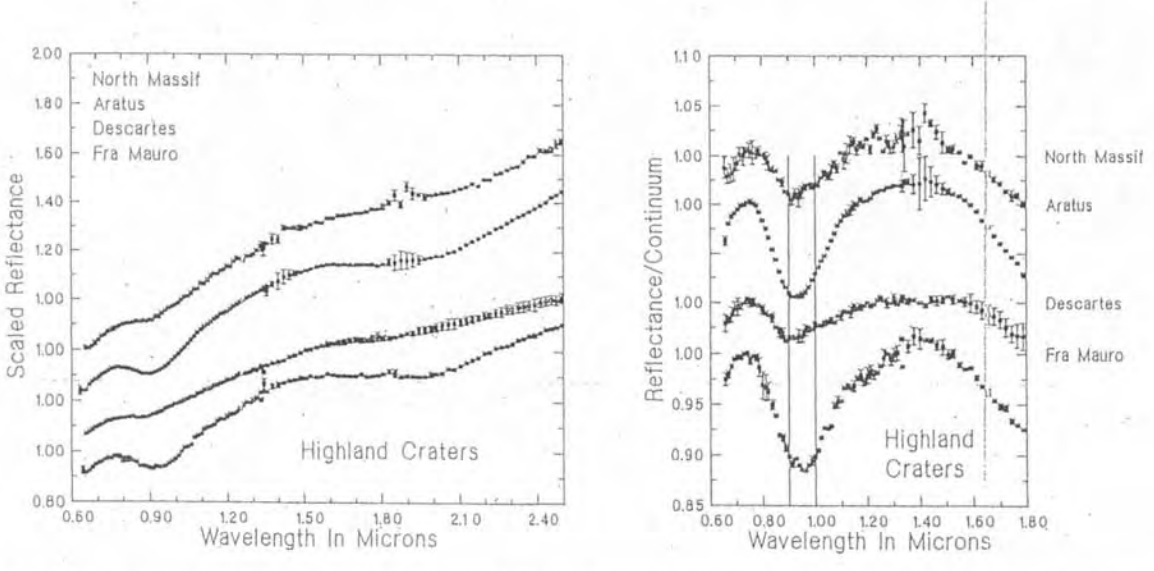
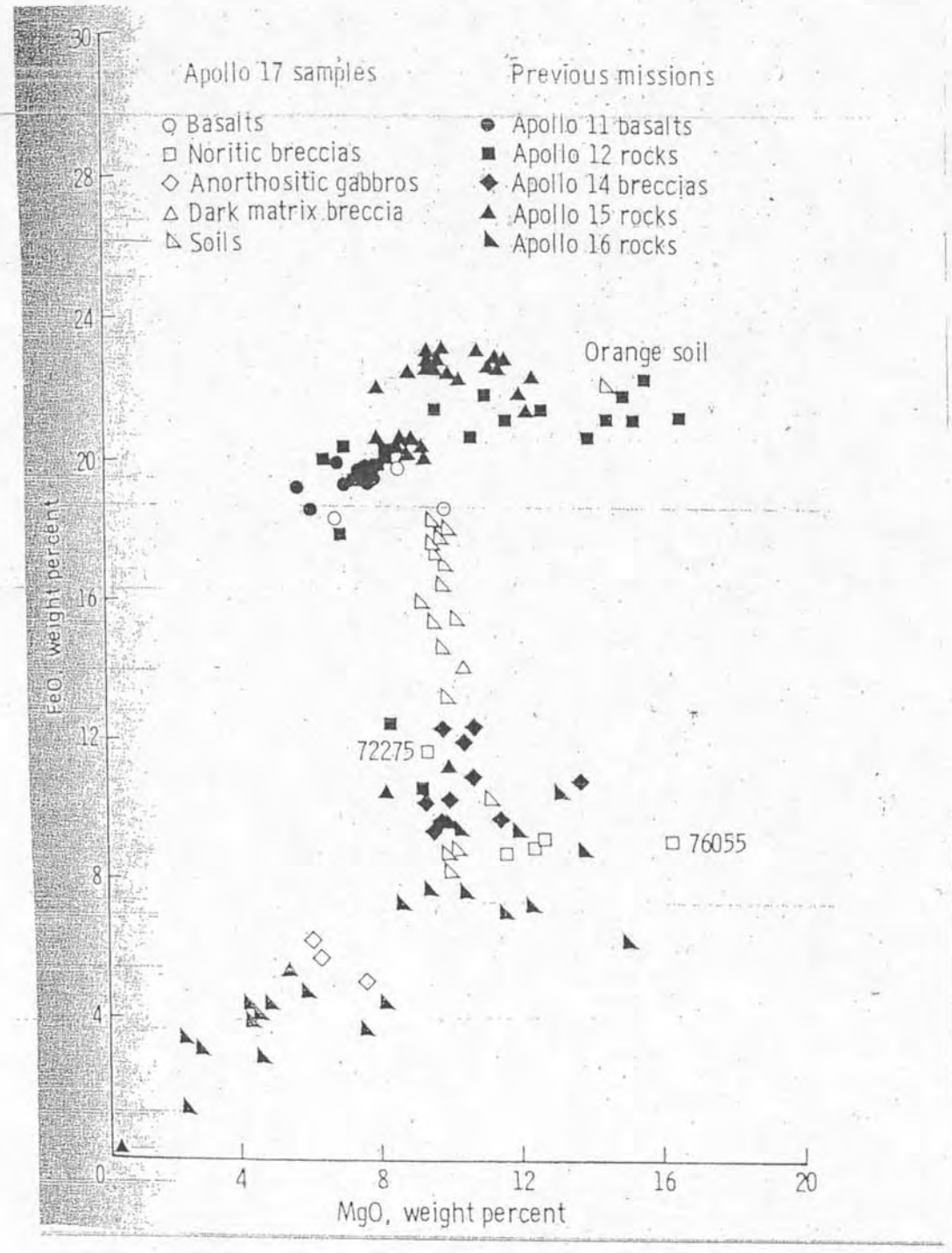


Fig. 14.12. Telescopic reflectance spectra for small highland craters and massifs. All spectra are scaled to unity at 1.02 μm and offset for clarity. Absorption bands with band centers between 0.91 and 0.93 μm indicating low-Ca pyroxenes, are the dominant mafic mineral present, and the general rock type is noritic. Differences in band strength reflect differences in pyroxene abundance. One small crater in the Fra Mauro region exhibits a band center closer to 0.95 μm, indicating an additional component of high-Ca pyroxene.

Earth-based Reflectance Specta for Highland Craters and Massifs: "general rock type is noritic"

(Pieters, 1993)



Apollo 17 Rocks and Soils, MgO vs FeO
(Apollo 17 Preliminary Science Report)

TABLE 14.1. Composition observed at lunar craters with central peaks (listed west to east).

Crater Region	Diameter km	Crustal Composition		Band Strength %	Sampling Depth km (est.)
		Upper	Lower		
Aristarchus	41	gabbro	gabbro/troctolite	8	4
Lansberg	40	norite	norite	9	4
Copernicus	96	norite	troctolite	12	10
Bullialdus	61	gabbro(2)	norite	17	6
Eratosthenes	63	norite	gabbro	7	6
Tycho	90	gabbro	gabbro	17	9
Alphonsus	119	norite	anorthosite	<1	12
Arzachel	99	norite	norite	6	10
Aristillus	55	norite	norite	14	5
Theophilius	100	norite	anorthosite	<1	10
Piccolomini	88	norite	anorthosite	<1	9
Petavius	177	norite	anorthosite	<1	17
Langrenus	136	norite	norite	5	14

Table 1

Compositions from Spectral Reflectance of Lunar Craters with Central Peaks

(Pieters, 1993)

SUMMARY: THE LUNAR HIGHLAND CRUST

- Age: 4 to 4.5 Ga
- Structure: lava flows, several km thick;all mantled by impact-formed regolith
- Composition: High-Al basalt, norite
- Petrography: Feldspathic hypersthene basalt
- Intrusive rocks: anorthosite,norite, troctolite, gabbro,KREEP (exposed in crater floors, central peaks)