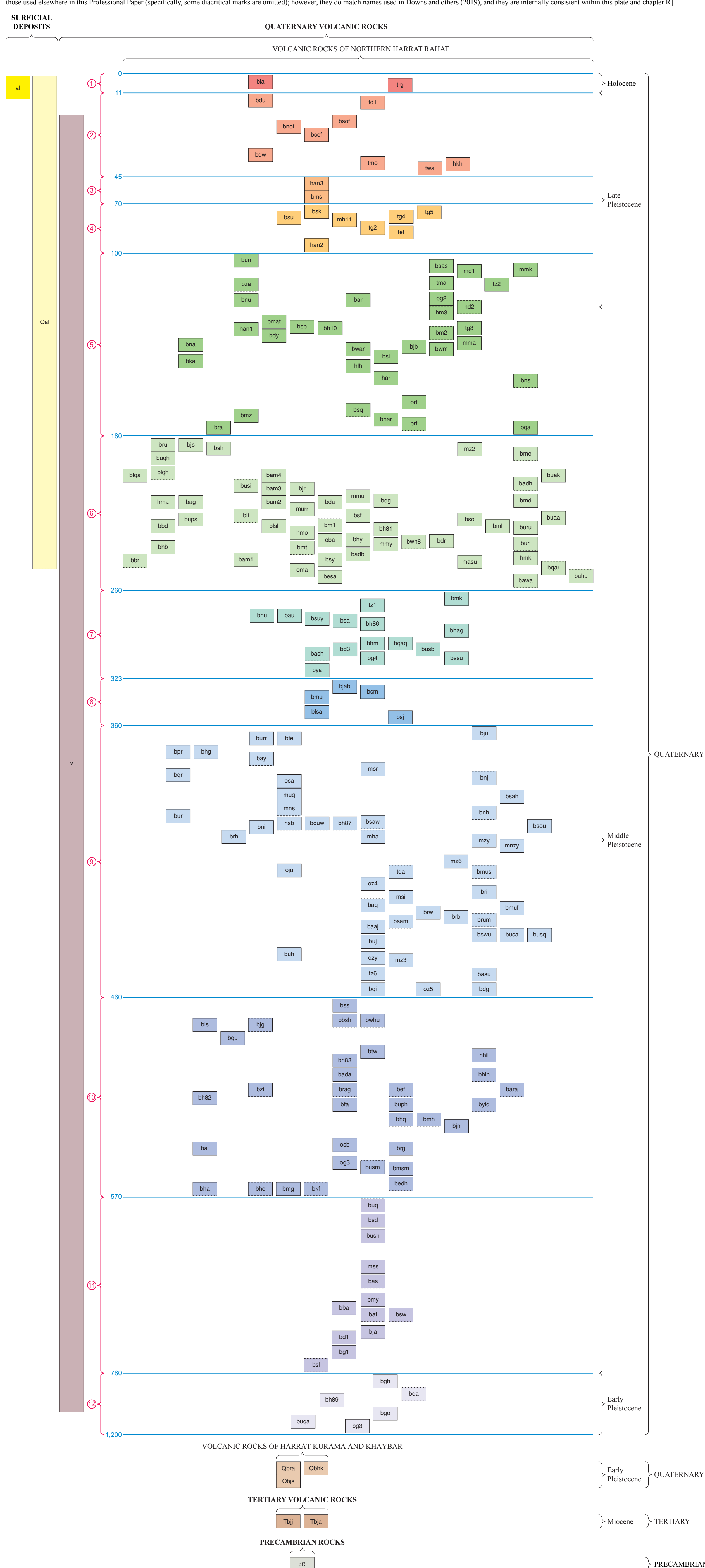


CORRELATION OF MAP UNITS

[Map units are divided into surficial deposits. Quaternary volcanic rocks, Tertiary volcanic rocks, and Precambrian rocks. Quaternary volcanic rocks consist of acidified ventrite tuffs, volcanic rocks of northern Harat Laharic volcanic field, volcanic rocks of Hamis Karakoram and Khaybar (Harat) Karakoram adjoin northern Harat Lahar along its northeast side, closest Harat Khaybar vent is 30 kilometers north-northeast of northern Harat Lahar. Volcanic rocks of northern Harat Lahar volcanic field are subdivided into 12 eruptive stages (Fig. 1), terrane ages, and red brackets indicate their age values. The numbers above approximate ages (in ka) thousand years ago] of eruptive stage deposits. Volcanic rocks of northern Harat Lahar volcanic field are arranged vertically, in stratigraphic and chronological order within eruptive stages, and horizontally, in generally north-to-south order. Volcanic rocks not associated with northern Harat Lahar volcanic field are subdivided into volcanic rocks of Harat Karakoram and Khaybar (Qzrs, Ggs, Qgrs and Terro). Unidentified volcanic rocks are shown as gray shaded areas. The map units are described in detail in chapter 8 of this report for full unit names and descriptions, precise unit ages, and detailed stratigraphic correlations. Note that some geographic names used on this plate (and in chapter 8) may not exactly match.

[illegible]

LIST OF MAP UNITS

1	Basalt of Al Madhah (middle Pleistocene)	msf	Mugarrat of Sha'ib Rushaynah (middle Pleistocene)
2	Basalt of Al Miesha'a (middle Pleistocene)	msq	Mugarrat of Um Qura (middle Pleistocene)
3	Basalt of Al Malyah (middle Pleistocene)	msj	Mugarrat of Um Zuhrah 3 (middle Pleistocene)
4	Basalt of Mutam (middle Pleistocene)	msk	Mugarrat of Um Zuhrah 4 (middle Pleistocene)
5	Basalt of Al Qura'a (middle Pleistocene)	msy	Mugarrat of As Zaynah (middle Pleistocene)
6	Basalt of Qa' Al Ghassan (middle Pleistocene)	msa	Bonemuric of Um Jash (middle Pleistocene)
7	Basalt of Qa' Al Haddad (middle Pleistocene)	msb	Bonemuric of Al Madyan (middle Pleistocene)
8	Basalt of Um Sa'ad (middle Pleistocene)	msc	Bonemuric of Um Zuhrah 4 (middle Pleistocene)
9	Basalt of Shura (middle Pleistocene)	msd	Bonemuric of Um Zuhrah 5 (middle Pleistocene)
10	Basalt of Samsa (middle Pleistocene)	msf	Bonemuric of As Zaynah (middle Pleistocene)
11	Basalt of Ash Silyah (middle Pleistocene)	trk	Trachyte of Al Qay (middle Pleistocene)
12	Basalt of Um Al Awwah (middle Pleistocene)	trf	Trachyte of Um Zuhrah (middle Pleistocene)
13	Basalt of Um Arakab (middle Pleistocene)		Empire Stage 10 (460 to 570 ka)
14	Basalt of Upper Sahab (middle Pleistocene)	bsh	Basalt of Al Baydar (middle Pleistocene)
15	Basalt of Upper Qa' Hadawah (middle Pleistocene)	bsl	Basalt of Al Bu (middle Pleistocene)
16	Basalt of Upper Ar Rataj (middle Pleistocene)	bsh	Basalt of Ar Rataj (middle Pleistocene)
17	Basalt of Um Rutaj (middle Pleistocene)	bsh	Basalt below Ash Samah (middle Pleistocene)
18	Basalt of Upper Sha'ib Isakab (middle Pleistocene)	bsh	Basalt east of Dab al Bu (middle Pleistocene)
19	Basalt west of Hill 879 (middle Pleistocene)	bsf	Basalt of Al Efaris (middle Pleistocene)
20	Hawait of Al Ma'as (middle Pleistocene)	bsa	Basalt of Al Farah (middle Pleistocene)
21	Hawait of Mukhayr (middle Pleistocene)	bsb	Basalt of Hill 821 (middle Pleistocene)
22	Hawait of Mouten (middle Pleistocene)	bsc	Basalt of Hill 828 (middle Pleistocene)
23	Mugarrat of As Samak (middle Pleistocene)	bsd	Basalt of Hahm (middle Pleistocene)
24	Mugarrat of Al Madya (middle Pleistocene)	bsf	Basalt of Haff' Um (middle Pleistocene)
25	Mugarrat of Muryah (middle Pleistocene)	bsg	Basalt of Al Hm (middle Pleistocene)
26	Mugarrat of Um Al Rosh (middle Pleistocene)	bsi	Basalt of Sha'ib Hupg (middle Pleistocene)
27	Mugarrat of Um Zuhrah 2 (middle Pleistocene)	bsj	Basalt of Al Iskan (middle Pleistocene)
28	Bonemuric of Al Bayad (middle Pleistocene)	bsk	Basalt of Al Jaz (middle Pleistocene)
29	Bonemuric of Al Madyan (middle Pleistocene)	bsl	Basalt of An Jaz (middle Pleistocene)
30	Basalt of Ash Samah (middle Pleistocene)	bsm	Basalt of Al Khafaj (middle Pleistocene)
31	Basalt of Ash Shamsi (middle Pleistocene)	bsn	Basalt of Al Mughayyah (middle Pleistocene)
32	Basalt of An Nughayr (middle Pleistocene)	bsh	Basalt of Al Muq'ayh (middle Pleistocene)
33	Basalt of Daba 3 (middle Pleistocene)	bsh	Basalt of Al Musannu (middle Pleistocene)
34	Basalt of Hill 865 (middle Pleistocene)	bsh	Basalt of Quba (middle Pleistocene)
35	Basalt of Hilay at Chawayyah (middle Pleistocene)	bsg	Basalt of Ar Raqibah (middle Pleistocene)
36	Basalt of Al Hamra (middle Pleistocene)	bsg	Basalt of Um Raqibah (middle Pleistocene)
37	Basalt of Al Huzayn (middle Pleistocene)	bsh	Basalt of Sha'ib S'iyad (middle Pleistocene)
38	Basalt of Mukhayr (middle Pleistocene)	bsh	Basalt of Ash Tuma'dah West (middle Pleistocene)
39	Basalt of Qa' Al Qina'a (middle Pleistocene)	bsh	Basalt of Upper Sha'ib Hupg (middle Pleistocene)
40	Basalt of Al Shatha (middle Pleistocene)	bsh	Basalt of Upper Sha'ib Muryah (middle Pleistocene)
41	Basalt south of As Samak (middle Pleistocene)	bsh	Basalt west of Al Haras (middle Pleistocene)
42	Basalt of Um Sayr (middle Pleistocene)	bsh	Basalt of Yidun (middle Pleistocene)
43	Basalt of Al Ush'a (middle Pleistocene)	bsh	Basalt of As Zaynah (middle Pleistocene)
44	Basalt of Yalla (middle Pleistocene)	bsh	Hawait of Hilay (middle Pleistocene)
45	Bonemuric of Qura 4 (middle Pleistocene)	bsg	Bonemuric of Qura 3 (middle Pleistocene)
46	Trachyte of Um Zuhrah 1 (middle Pleistocene)	trf	Bonemuric of As Zaynah (middle Pleistocene)
47	Empire Stage 9 (321 to 366 ka)		Empire Stage 10 (460 to 570 ka)
48	Basalt of Jabal (middle Pleistocene)	bsh	Basalt of Ash Sidrah (middle Pleistocene)
49	Basalt of Al Mawrah (middle Pleistocene)	bsh	Basalt of Ajm (middle Pleistocene)
50	Basalt of Al Mostak (middle Pleistocene)	bsh	Basalt of Al Raqabah (middle Pleistocene)
51	Basalt south of Al Jafrah (middle Pleistocene)	bsh	Basalt of Daba 1 (middle Pleistocene)
52	Basalt of Sha'ib Muryah (middle Pleistocene)	bsh	Basalt of Qura 1 (middle Pleistocene)
53	Empire Stage 9 (360 to 466 ka)	bsh	Basalt of Al Jar' (middle Pleistocene)
54	Basalt of Abul Al-Jad (middle Pleistocene)	bsh	Basalt of Al Madyan (middle Pleistocene)
55	Basalt of Al Quril (middle Pleistocene)	bsh	Basalt of Sha'ib Al Dirwan (middle Pleistocene)
56	Basalt of As Samak (middle Pleistocene)	bsh	Basalt of Sha'ib Al Madyan (middle Pleistocene)
57	Basalt of As Samak (middle Pleistocene)	bsh	Basalt of Um Sawa (middle Pleistocene)
58	Basalt of Dhuwaj'ah (middle Pleistocene)	bsh	Basalt of Um Qubayr (middle Pleistocene)
59	Basalt of Al Thoray'ah (middle Pleistocene)	bsh	Basalt of Usha'a (middle Pleistocene)
60	Basalt of Hill 870 (middle Pleistocene)	msa	Mugarrat southwest of Al Shatha (middle Pleistocene)
61	Basalt of Al Harb Al Charbiyah (middle Pleistocene)		Empire Stage 10 (460 to 570 ka)
62	Basalt of Al Jarb (middle Pleistocene)	bsg	Basalt of Qura 3 (early Pleistocene)
63	Basalt of Al Muryah (middle Pleistocene)	bsg	Basalt of Ghawar (early Pleistocene)
64	Basalt of Al Muryah (middle Pleistocene)	bsg	Basalt of Gura (early Pleistocene)
65	Basalt of Al Nag'ah (middle Pleistocene)	bsg	Basalt of Hill 892 (early Pleistocene)
66	Basalt of Al Madyan (middle Pleistocene)	bsg	Basalt of Al Qad' (early Pleistocene)
67	Basalt north of Al Jafrah (middle Pleistocene)	bsg	Basalt of Qura 3 (early Pleistocene)
68	Basalt of Powerr Road (middle Pleistocene)	bsg	Basalt of Qura 3 (early Pleistocene)
69	Basalt of Al Qiray (middle Pleistocene)	bsg	Basalt of Qura 3 (early Pleistocene)
70	Basalt of Qurayyah (middle Pleistocene)	bsg	Basalt of Harat Karak (early Pleistocene)
71	Basalt of Rawa Al Baham (middle Pleistocene)	bsg	Basalt of Jabal Um Sahyab (early Pleistocene)
72	Basalt of Rahat (middle Pleistocene)	bsg	Basalt of Ar Ramran (early Pleistocene)
73	Basalt of Ar Rataj (middle Pleistocene)	bsg	Basalt of Ar Rataj (early Pleistocene)
74	Basalt of Ar Ramayyah (middle Pleistocene)	bsg	Basalt of Ar Ramayyah (early Pleistocene)
75	Basalt of Rawa Al Baham (middle Pleistocene)	bsg	Basalt of Ar Ramayyah (early Pleistocene)
76	Basalt of Sha'ib Al Muryah (middle Pleistocene)	bsg	Basalt of Sha'ib Al Muryah (early Pleistocene)
77	Basalt of Sha'ib Al Muryah (middle Pleistocene)	bsg	Basalt of Sha'ib Al Muryah (early Pleistocene)
78	Basalt of Sha'ib Al Muryah (middle Pleistocene)	bsg	Basalt of Sha'ib Al Muryah

EXPLANATION OF MAP SYMBOLS

Contact—Solid where location is accurate; long-dashed where location is approximate; short-dashed where location is inferred. Internal contacts delineate individual vents

Cryptodome boundary—May coincide with contact between mapped units

Fault—Accurately located. Bar and ball on downdropped block

Ground cracks

Graben trace

Eruptive vent, crater, dome, or cryptodome

vein axis—Main vein axis (1) encompasses eruptive veins for most of northern Harat Rahat; western subsidiary

vent axis (2) encompasses fewer and more diffuse eruptive vents

Read

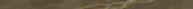
Railroad

Boundary between unmapped Harrat Rahat and other unmapped rocks and sediments

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Figure 1. The effect of the concentration of the solution on the adsorption of the dye. The concentration of the solution was 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 15.0, 20.0, 30.0, 40.0, 50.0, 60.0, 70.0, 80.0, 90.0, 100.0, 150.0, 200.0, 300.0, 400.0, 500.0, 600.0, 700.0, 800.0, 900.0, 1000.0, 1500.0, 2000.0, 3000.0, 4000.0, 5000.0, 6000.0, 7000.0, 8000.0, 9000.0, 10000.0, 15000.0, 20000.0, 30000.0, 40000.0, 50000.0, 60000.0, 70000.0, 80000.0, 90000.0, 100000.0, 150000.0, 200000.0, 300000.0, 400000.0, 500000.0, 600000.0, 700000.0, 800000.0, 900000.0, 1000000.0, 1500000.0, 2000000.0, 3000000.0, 4000000.0, 5000000.0, 6000000.0, 7000000.0, 8000000.0, 9000000.0, 10000000.0, 15000000.0, 20000000.0, 30000000.0, 40000000.0, 50000000.0, 60000000.0, 70000000.0, 80000000.0, 90000000.0, 100000000.0, 150000000.0, 200000000.0, 300000000.0, 400000000.0, 500000000.0, 600000000.0, 700000000.0, 800000000.0, 900000000.0, 1000000000.0, 1500000000.0, 2000000000.0, 3000000000.0, 4000000000.0, 5000000000.0, 6000000000.0, 7000000000.0, 8000000000.0, 9000000000.0, 10000000000.0, 15000000000.0, 20000000000.0, 30000000000.0, 40000000000.0, 50000000000.0, 60000000000.0, 70000000000.0, 80000000000.0, 90000000000.0, 100000000000.0, 150000000000.0, 200000000000.0, 300000000000.0, 400000000000.0, 500000000000.0, 600000000000.0, 700000000000.0, 800000000000.0, 900000000000.0, 1000000000000.0, 1500000000000.0, 2000000000000.0, 3000000000000.0, 4000000000000.0, 5000000000000.0, 6000000000000.0, 7000000000000.0, 8000000000000.0, 9000000000000.0, 10000000000000.0, 15000000000000.0, 20000000000000.0, 30000000000000.0, 40000000000000.0, 50000000000000.0, 60000000000000.0, 70000000000000.0, 80000000000000.0, 90000000000000.0, 100000000000000.0, 150000000000000.0, 200000000000000.0, 300000000000000.0, 400000000000000.0, 500000000000000.0, 600000000000000.0, 700000000000000.0, 800000000000000.0, 900000000000000.0, 1000000000000000.0, 1500000000000000.0, 2000000000000000.0, 3000000000000000.0, 4000000000000000.0, 5000000000000000.0, 6000000000000000.0, 7000000000000000.0, 8000000000000000.0, 9000000000000000.0, 10000000000000000.0, 15000000000000000.0, 20000000000000000.0, 30000000000000000.0, 40000000000000000.0, 50000000000000000.0, 60000000000000000.0, 70000000000000000.0, 80000000000000000.0, 90000000000000000.0, 100000000000000000.0, 150000000000000000.0, 200000000000000000.0, 300000000000000000.0, 400000000000000000.0, 500000000000000000.0, 600000000000000000.0, 700000000000000000.0, 800000000000000000.0, 900000000000000000.0, 1000000000000000000.0, 1500000000000000000.0, 2000000000000000000.0, 3000000000000000000.0, 4000000000000000000.0, 5000000000000000000.0, 6000000000000000000.0, 7000000000000000000.0, 8000000000000000000.0, 9000000000000000000.0, 10000000000000000000.0, 15000000000000000000.0, 20000000000000000000.0, 30000000000000000000.0, 40000000000000000000.0, 50000000000000000000.0, 60000000000000000000.0, 70000000000000000000.0, 80000000000000000000.0, 90000000000000000000.0, 100000000000000000000.0, 150000000000000000000.0, 200000000000000000000.0, 300000000000000000000.0, 400000000000000000000.0, 500000000000000000000.0, 600000000000000000000.0, 700000000000000000000.0, 800000000000000000000.0, 900000000000000000000.0, 1000000000000000000000.0, 1500000000000000000000.0, 2000000000000000000000.0, 3000000000000000000000.0, 4000000000000000000000.0, 5000000000000000000000.0, 6000000000000000000000.0, 7000000000000000000000.0, 8000000000000000000000.0, 9000000000000000000000.0, 10000000000000000000000.0, 15000000000000000000000.0, 20000000000000000000000.0, 30000000000000000000000.0, 40000000000000000000000.0, 50000000000000000000000.0, 60000000000000000000000.0, 70000000000000000000000.0, 80000000000000000000000.0, 90000000000000000000000.0, 100000000000000000000000.0, 150000000000000000000000.0, 200000000000000000000000.0, 300000000000000000000000.0, 400000000000000000000000.0, 500000000000000000000000.0, 600000000000000000000000.0, 700000000000000000000000.0, 800000000000000000000000.0, 900000000000000000000000.0, 10000000

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