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Plume–ridge interactions: ridgeward versus plate-drag plume flow

Fengping Pang et al.

Correspondence to: Jie Liao (liaojie5@mail.sysu.edu.cn)

Contents of this file

Figures S1 to S8

Table S1

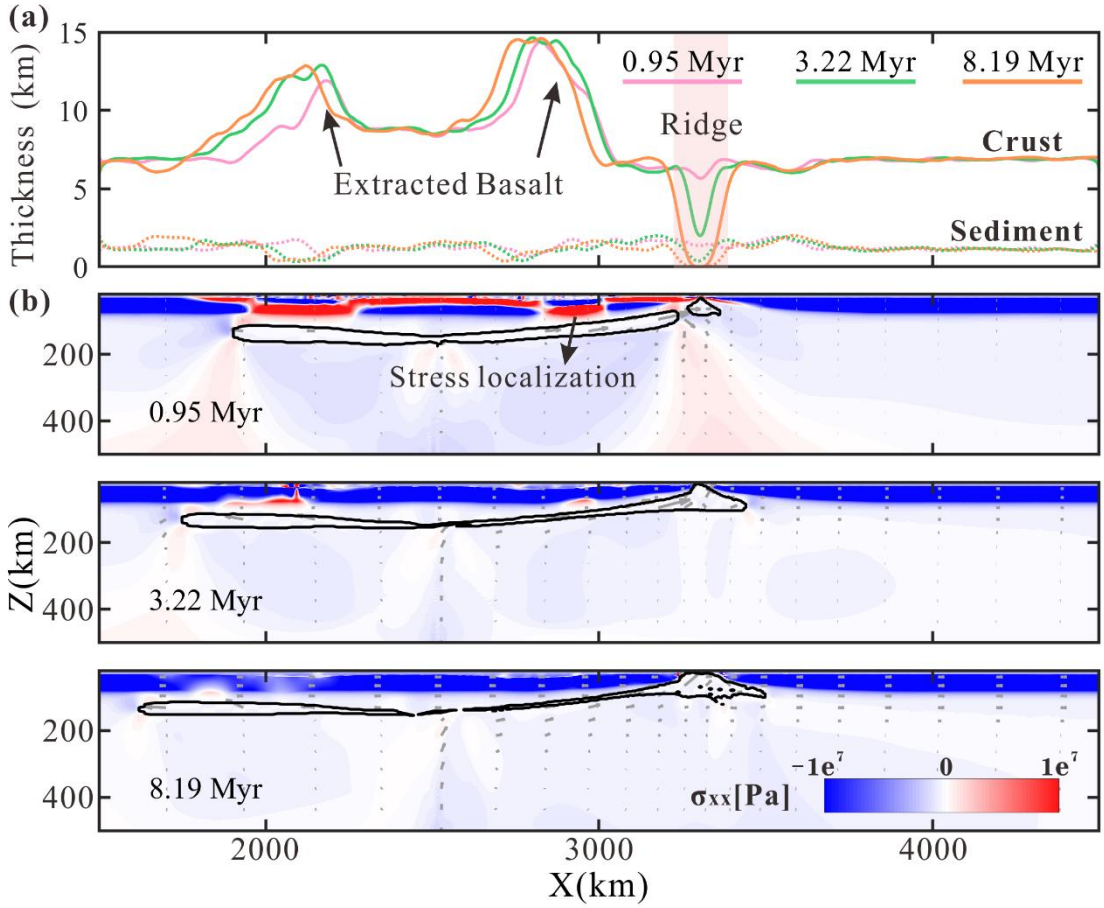

Figure S1. Reference model (M12, see Table S1, same as Fig. 3) evolution of ridge-ward plume flow shown by (a) crust and sediment thickness, (b) normal stress. The mantle plume weakens the overlying oceanic plate and changes the stress state of the overlying oceanic plate. Molten plume material beneath the lithosphere is extracted to the crust.

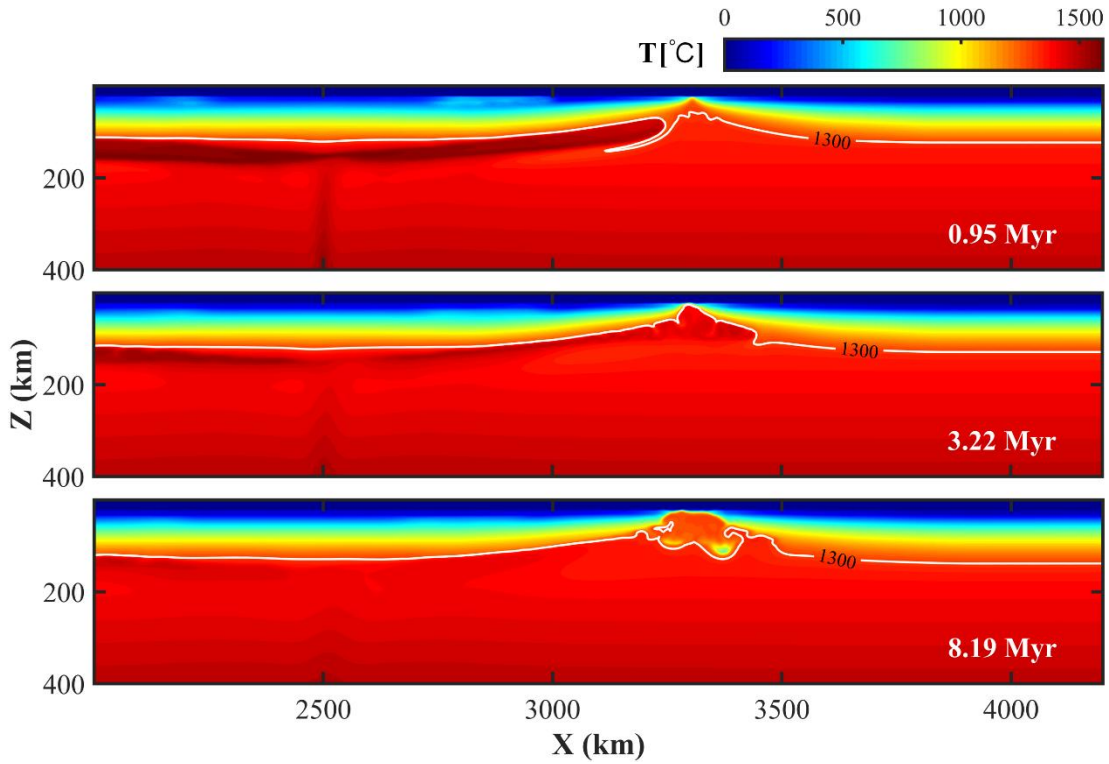

Figure S2. Temperature evolution of reference ridge-ward plume flow model (M12, see Table S1, same as Fig. 3).

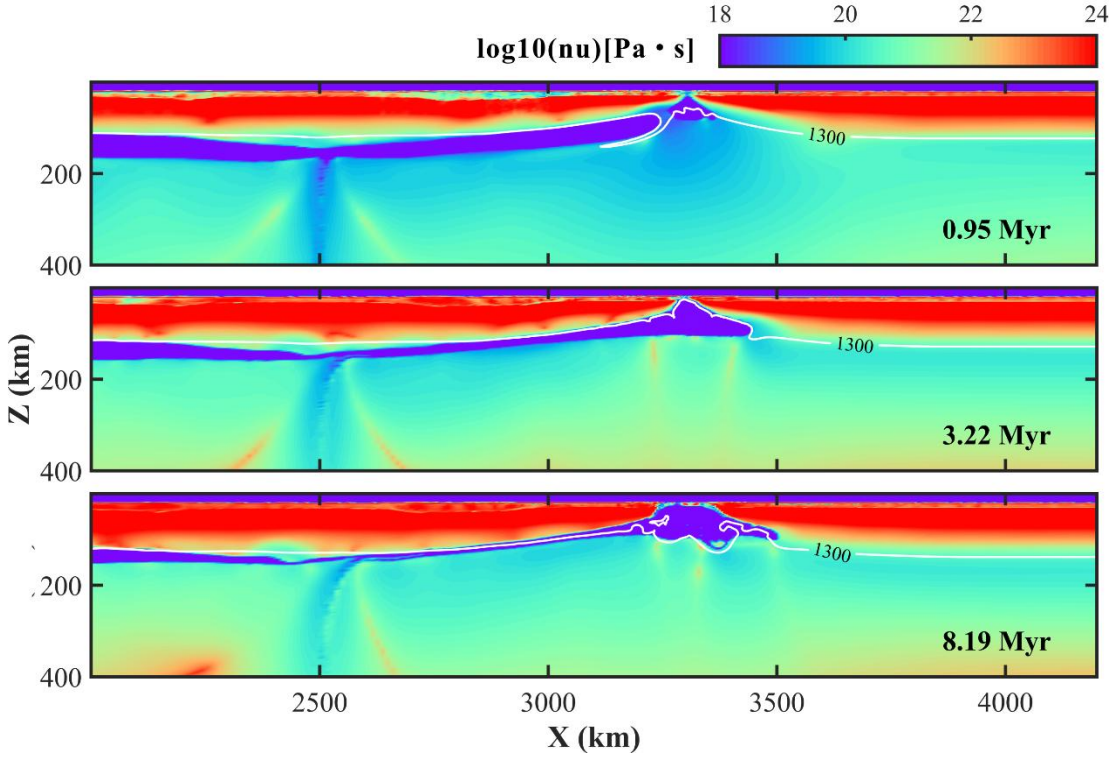

Figure S3. Viscosity evolution of reference ridge-ward plume flow model (M12, see Table S1, same as Fig. 3).

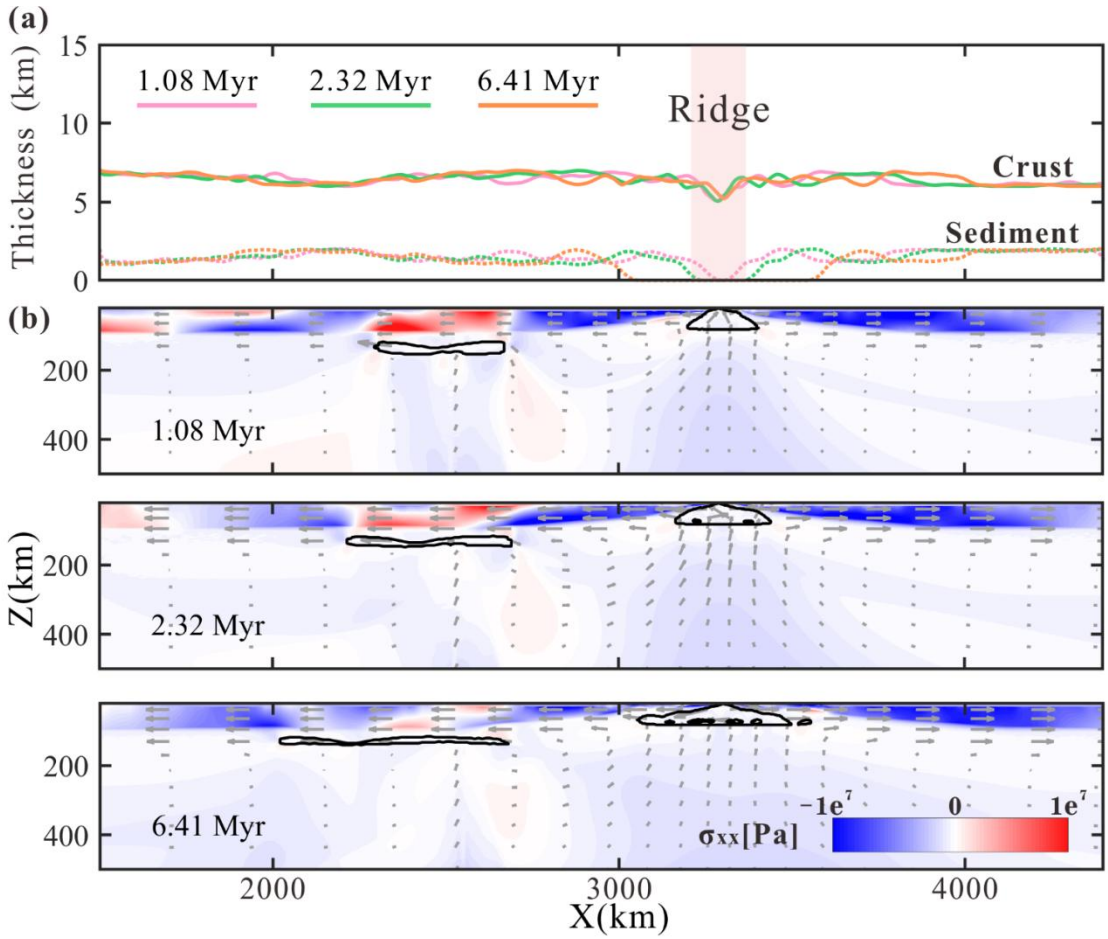

Figure S4. Reference model (M77, see Table S1, same as Fig. 4) evolution of plate-drag plume flow shown by (a) crust and sediment thickness, (b) normal stress. The mantle plume weakens the overlying oceanic plate and changes the stress state of the overlying oceanic plate. Molten plume material beneath the lithosphere is extracted to the crust.

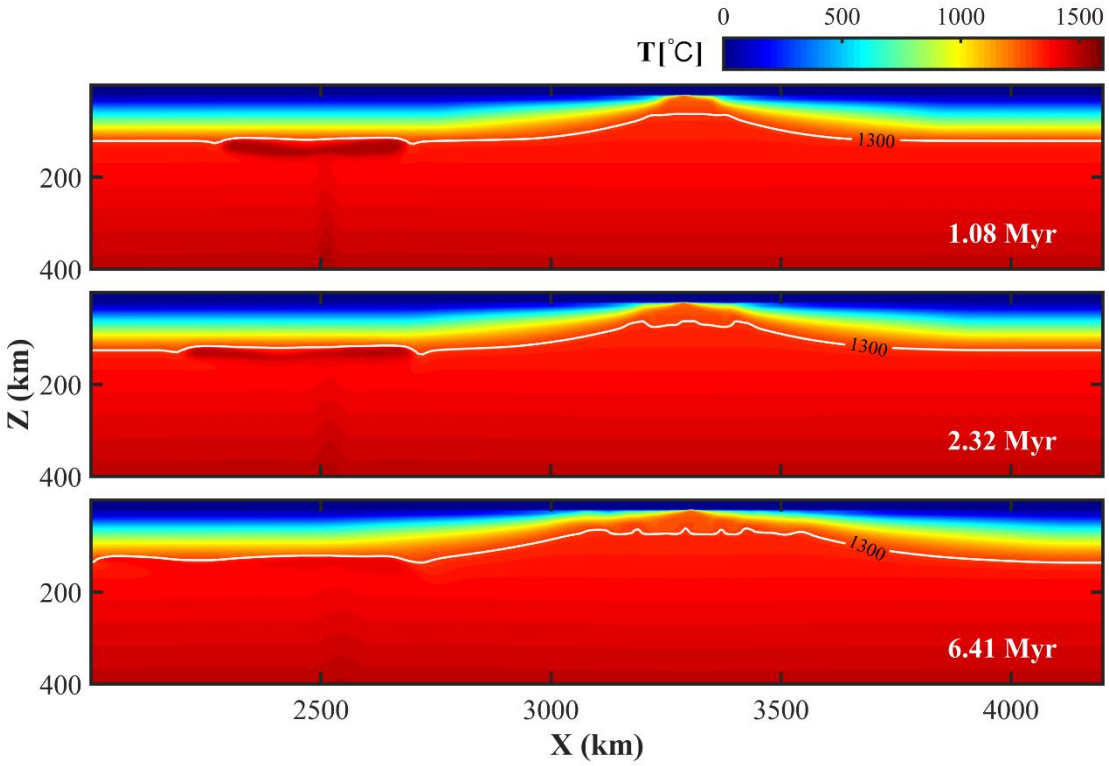

Figure S5. Temperature evolution of reference plate-drag plume flow model (M77, see Table S1, same as Fig. 4).

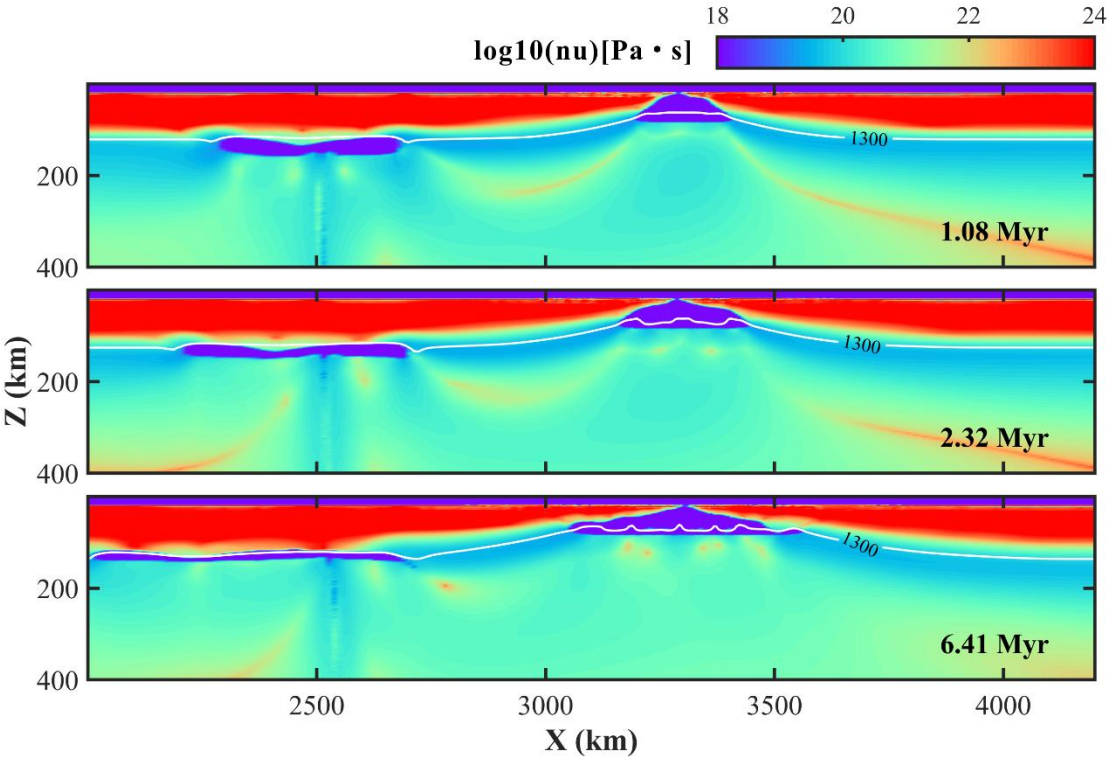

Figure S6. Viscosity evolution of reference plate-drag plume flow model (M77, see Table S1, same as Fig. 4).

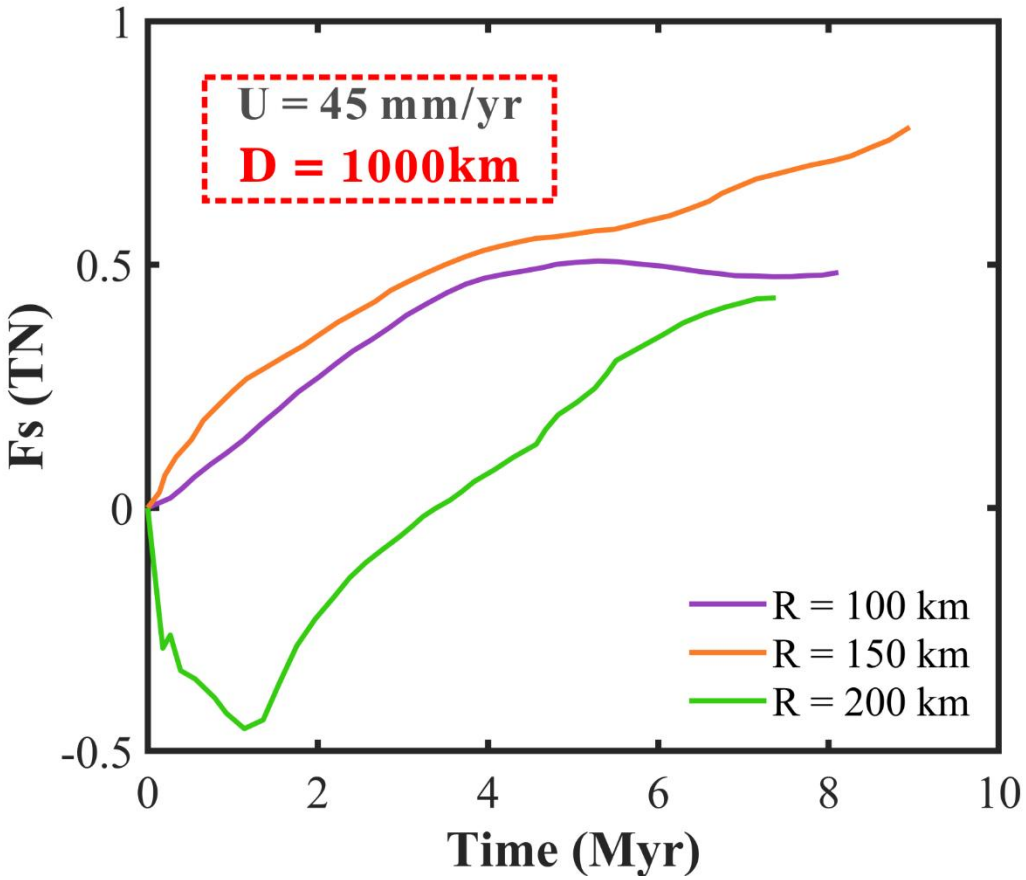

Figure S7. Shear force (*Fs*) between plate and plume in different plume head size models. The shear force imposed on the plume increases with plume size. The negative shear force indicates stronger friction imposed on the ridge-ward flowing (right) plume branch than that on the plate-drag flowing (left) plume branch.

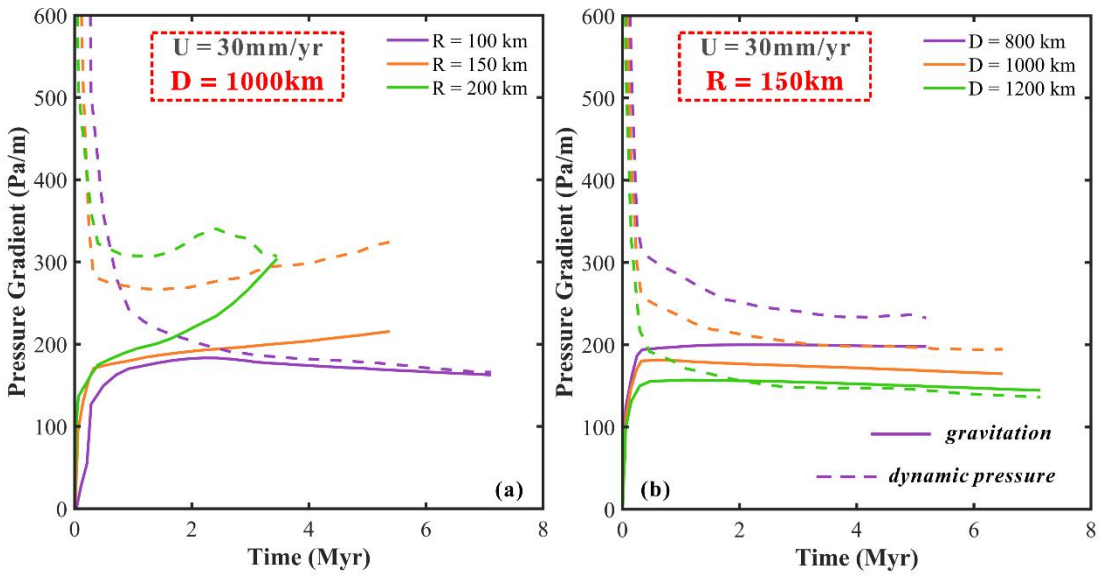

Figure S8. Pressure gradient between plume head and ridge center. The plume gravitation (solid lines) and dynamic pressure gradient (dash lines) of **(a)** different size plumes, **(b)** different plume-ridge distances are shown by solid and dash lines, respectively.

Table S1. Description of experiments.

Model	Ridge half spreading rate (mm/yr)	Plume radius (km)	Plume ridge distance (km)	Plume excess temperature (K)	Regimes
M1	8	100	600	250	Ridge-ward flow
M2	8	100	800	250	Plate-drag flow
M3	8	100	1000	250	Plate-drag flow
M4	8	100	1200	250	Plate-drag flow
M5	8	100	1400	250	Plate-drag flow
M6	8	150	600	250	Ridge-ward flow
M7	8	150	800	250	Ridge-ward flow
M8	8	150	1000	250	Ridge-ward flow
M9	8	150	1200	250	Ridge-ward flow
M10	8	150	1400	250	Ridge-ward flow
M11	8	200	600	250	Ridge-ward flow
M12	8	200	800	250	Ridge-ward flow
M13	8	200	1000	250	Ridge-ward flow
M14	8	200	1200	250	Ridge-ward flow
M15	8	200	1400	250	Ridge-ward flow
M16	8	250	600	250	Ridge-ward flow
M17	8	250	800	250	Ridge-ward flow
M18	8	250	1000	250	Ridge-ward flow
M19	8	250	1200	250	Ridge-ward flow
M20	8	250	1400	250	Ridge-ward flow
M21	8	300	600	250	Ridge-ward flow
M22	8	300	800	250	Ridge-ward flow
M23	8	300	1000	250	Ridge-ward flow
M24	8	300	1200	250	Ridge-ward flow
M25	8	300	1400	250	Ridge-ward flow
M26	15	100	600	250	Ridge-ward flow
M27	15	100	800	250	Plate-drag flow
M28	15	100	1000	250	Plate-drag flow
M29	15	100	1200	250	Plate-drag flow
M30	15	100	1400	250	Plate-drag flow
M31	15	150	600	250	Ridge-ward flow
M32	15	150	800	250	Ridge-ward flow
M33	15	150	1000	250	Ridge-ward flow
M34	15	150	1200	250	Plate-drag flow
M35	15	150	1400	250	Plate-drag flow
M36	15	200	600	250	Ridge-ward flow
M37	15	200	800	250	Ridge-ward flow

M38	15	200	1000	250	Ridge-ward flow
M39	15	200	1200	250	Ridge-ward flow
M40	15	200	1400	250	Ridge-ward flow
M41	15	250	600	250	Ridge-ward flow
M42	15	250	800	250	Ridge-ward flow
M43	15	250	1000	250	Ridge-ward flow
M44	15	250	1200	250	Ridge-ward flow
M45	15	250	1400	250	Ridge-ward flow
M46	15	300	600	250	Ridge-ward flow
M47	15	300	800	250	Ridge-ward flow
M48	15	300	1000	250	Ridge-ward flow
M49	15	300	1200	250	Ridge-ward flow
M50	15	300	1400	250	Ridge-ward flow
M51	30	100	600	250	Ridge-ward flow
M52	30	100	800	250	Plate-drag flow
M53	30	100	1000	250	Plate-drag flow
M54	30	100	1200	250	Plate-drag flow
M55	30	100	1400	250	Plate-drag flow
M56	30	150	600	250	Ridge-ward flow
M57	30	150	800	250	Ridge-ward flow
M58	30	150	1000	250	Plate-drag flow
M59	30	150	1200	250	Plate-drag flow
M60	30	150	1400	250	Plate-drag flow
M61	30	200	600	250	Ridge-ward flow
M62	30	200	800	250	Ridge-ward flow
M63	30	200	1000	250	Ridge-ward flow
M64	30	200	1200	250	Ridge-ward flow
M65	30	200	1400	250	Plate-drag flow
M66	30	250	600	250	Ridge-ward flow
M67	30	250	800	250	Ridge-ward flow
M68	30	250	1000	250	Ridge-ward flow
M69	30	250	1200	250	Ridge-ward flow
M70	30	250	1400	250	Ridge-ward flow
M71	30	300	600	250	Ridge-ward flow
M72	30	300	800	250	Ridge-ward flow
M73	30	300	1000	250	Ridge-ward flow
M74	30	300	1200	250	Ridge-ward flow
M75	30	300	1400	250	Ridge-ward flow
M76	45	100	600	250	Ridge-ward flow
M77	45	100	800	250	Plate-drag flow
M78	45	100	1000	250	Plate-drag flow
M79	45	100	1200	250	Plate-drag flow
M80	45	100	1400	250	Plate-drag flow

M81	45	150	600	250	Ridge-ward flow
M82	45	150	800	250	Ridge-ward flow
M83	45	150	1000	250	Plate-drag flow
M84	45	150	1200	250	Plate-drag flow
M85	45	150	1400	250	Plate-drag flow
M86	45	200	600	250	Ridge-ward flow
M87	45	200	800	250	Ridge-ward flow
M88	45	200	1000	250	Ridge-ward flow
M89	45	200	1200	250	Plate-drag flow
M90	45	200	1400	250	Plate-drag flow
M91	45	250	600	250	Ridge-ward flow
M92	45	250	800	250	Ridge-ward flow
M93	45	250	1000	250	Ridge-ward flow
M94	45	250	1200	250	Ridge-ward flow
M95	45	250	1400	250	Ridge-ward flow
M96	45	300	600	250	Ridge-ward flow
M97	45	300	800	250	Ridge-ward flow
M98	45	300	1000	250	Ridge-ward flow
M99	45	300	1200	250	Ridge-ward flow
M100	45	300	1400	250	Ridge-ward flow