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Suspended Sediment Dynamics in Meltwater of the Aldegonda Glacier, Spitsbergen, 2016 and 2017

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The Aldegonda glacier (77°58'30.48"N, 14° 5'38.66"E) is located in western Spitsbergen on the west side of Gronfjord, 8km SSE of the Russian settlement of Barentsberg. The catchment area drained by the Aldegonda river is 14.2 km2 of which 6.0 km2 is currently ice. The Aldegonda glacier retreated approximately 2.4 km since 1912 when it reached sea level and entered Gronfjord. The highest point of the catchment reaches 670m and the current ice margins lie between 450-150m. This study aimed to examine the discharge-suspended sediment relationship over two melt seasons, 2016 and 2017.

88 water samples retrieved (25 in 2016, 63 in 2017) from a stable section of the Aldegonda river 400m from the fjord (∼2 km from the current ice margin) during the melt season were analysed by standard gravimetric procedure for their suspended sediment concentration (SSC). Discharge (Q) was measured using the velocity area method for each value of SSC recorded.

Mean SSC was higher in 2016 (608.4 ± 90.6 mg/L) than in 2017 (240.3 ± 39.0 mg/L). The discharge weighted SSC values for 2016 and 2017 were 0.16 and 0.12 respectively, indicating that even when the higher Q of 2016 is taken into account, mean SSC in 2016 was still higher than 2017. Mean suspended sediment load (SSL) was 2.57 ± 0.42 kg/s in 2016 and 0.75 ± 0.14 kg/s in 2017.

To investigate SSC-Q relationships the melt seasons were divided into early/mid/late phases. In 2016 no samples were collected in the early phase and the SSC-Q relationship was weak and not significant in the mid part of the 2016 melt season, but was much stronger and statistically significant (R2 0.71, $p < 0.01$) in the late melt season. The slope of the regression line was steeper (mid = 138.6; late = 185.9) in the late melt season, so for each incremental increase in Q, there was a correspondingly greater increase in SSC. In 2017 the SSC-Q relationship strengthened as the melt season progressed from early (R2 = 0.24, $p < 0{,}05$) > mid (R2 = 0.40, $p < 0.01$) > late (R2 = 0.66, $p < 0.001$) and in 2017 the slope of the regression lines also increased through the melt season (early = 126.2; mid = 165.4; late = 403.7) suggesting that SSC was transport limited, not supply limited. One diurnal event in each season was sampled at 2-h intervals and showed complex hysteresis loops. Towards the end of the 2016 event (after 16:00 on 22/7/16) there was a sudden sustained rise in SSC (for 3 samples over 6 hours) which was not fully explained by the rise in Q. This could indicate a new sediment source being activated as temperatures rose in the morning or as the sun hit the valley side or streambank, causing overnight frozen materials to melt and couple with the stream system (Irvine-Fynn, 2005), or it could be a slope failure, bank slump activated by some other cause such as a glacier surge.