



**institute
of mine
seismology**

**The comparison between borehole and
surface mount geophones and the
influence it has on the seismic source
parameters**

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Borehole geophones

- Borehole sensors are typically grouted in a borehole with a depth of at least 10m
- Therefore the sensor is in the solid rock away from fracture zones (attenuation)
- Away from any potential ground motion resonance (surface amplifications) on tunnels.





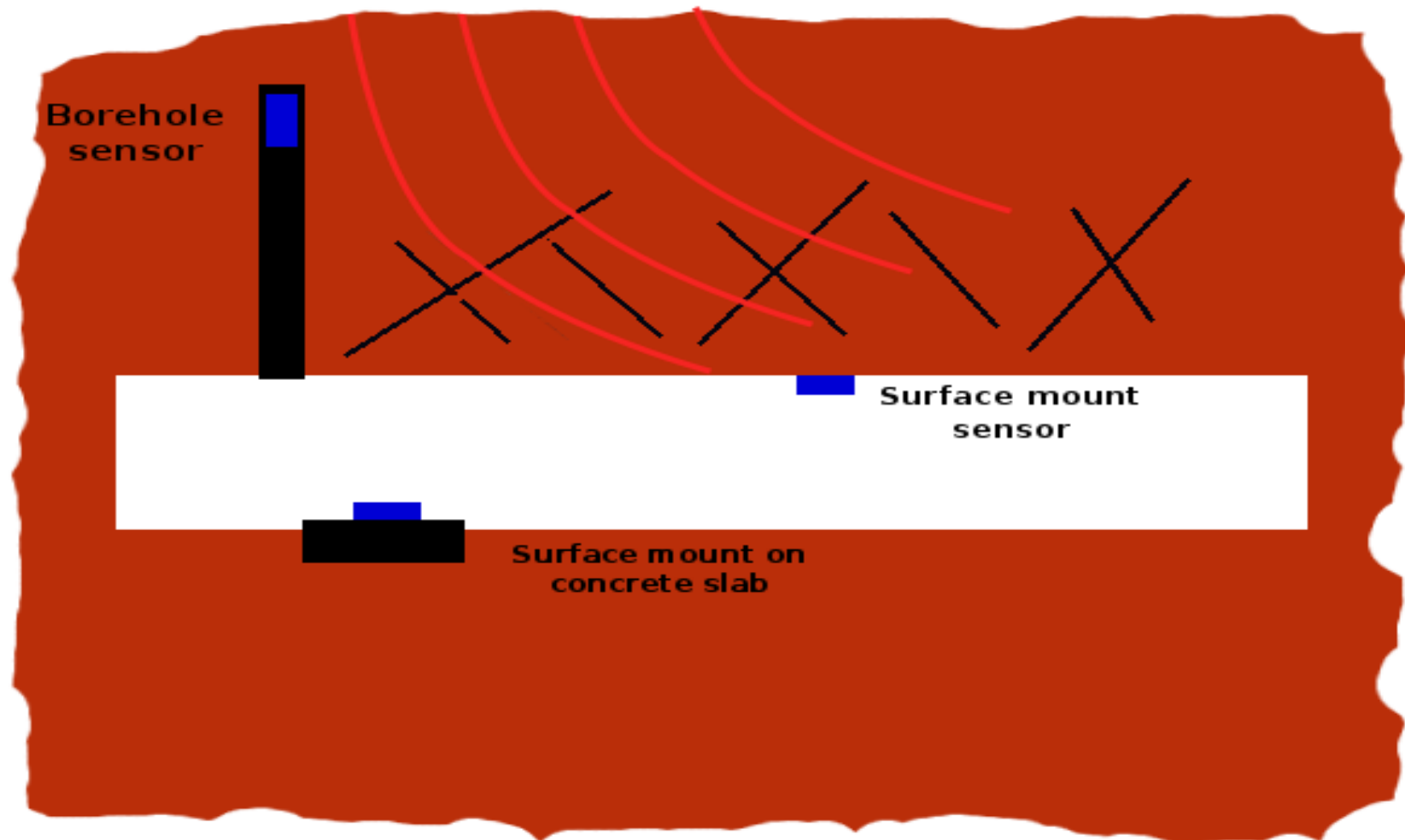
Surface mount geophones

- Surface mount sensors are typically bolted onto a rawl bar which has been grouted on the rock.
- Is subjected to any resonance on the tunnel
- Tunnel surfaces are comprised of fractured rock which will attenuate seismic waves.
- Can also be bolted onto a concrete slab which is anchored onto the bed rock.





Schematic diagram of the different sensor types





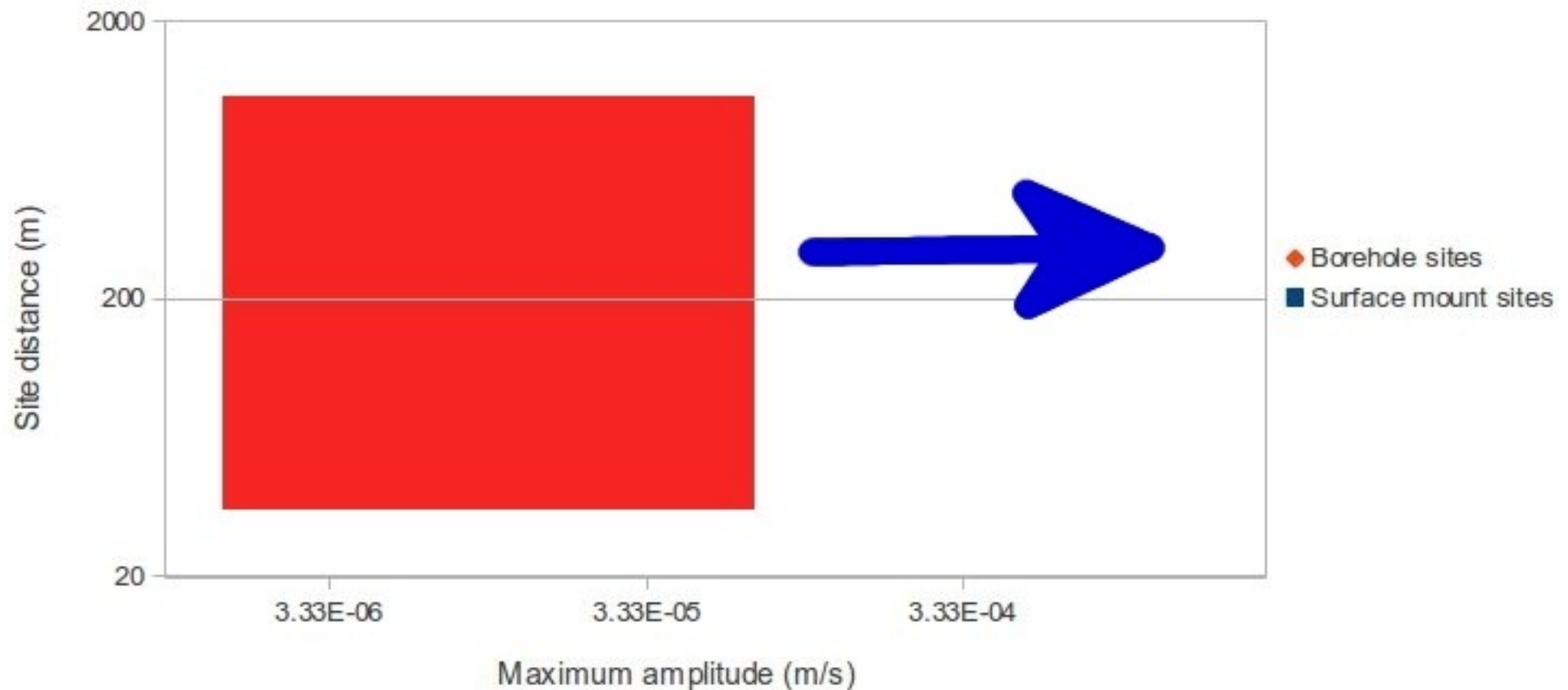
Investigation

- See if surface mount sensors are influenced by resonance on the tunnel which artificially boosts the magnitude.
- Comparison between the maximum amplitude for surface mount and borehole sensors.
- 2 case studies were done.
- Both mines had a combination of surface mount and borehole sensors.



What to expect

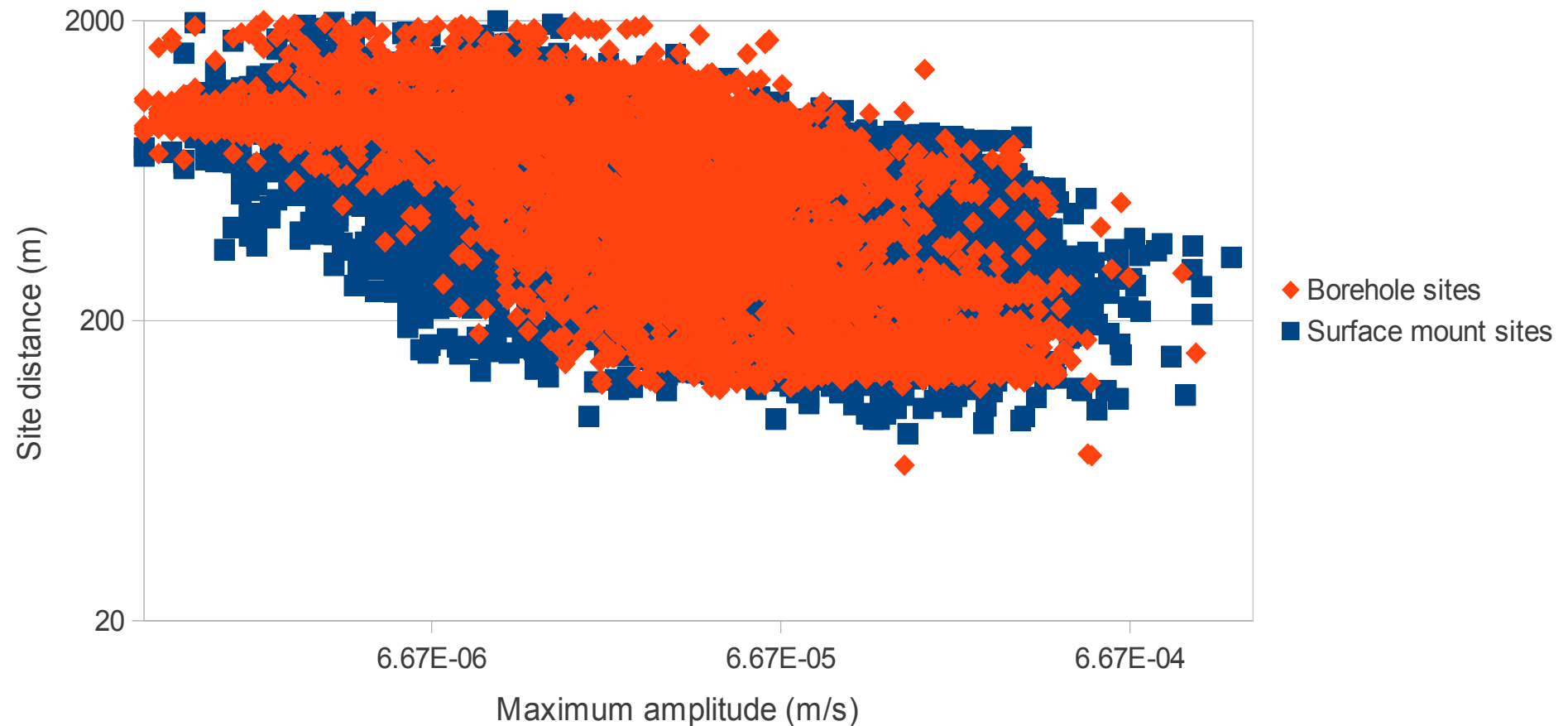
Comparison of borehole and surface mount sites
Maximum amplitude versus site distance





Case study 1 – Maximum amplitude vs site distance ($m < -1.0$)

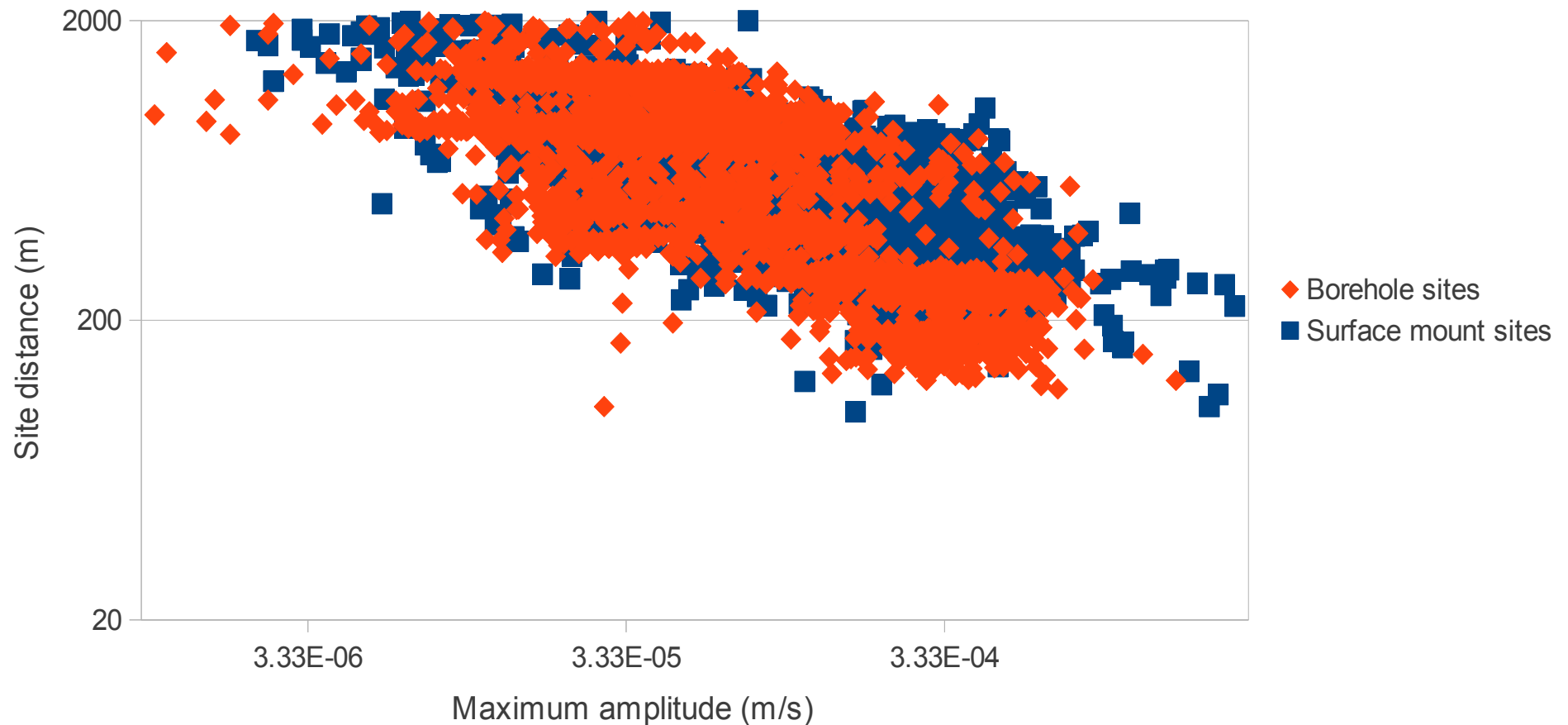
Comparison of borehole and surface mount sites -
Maximum amplitude versus site distance for events $m < -1.0$





Case study 1 – Maximum amplitude vs site distance ($-1.0 < m < -0.5$)

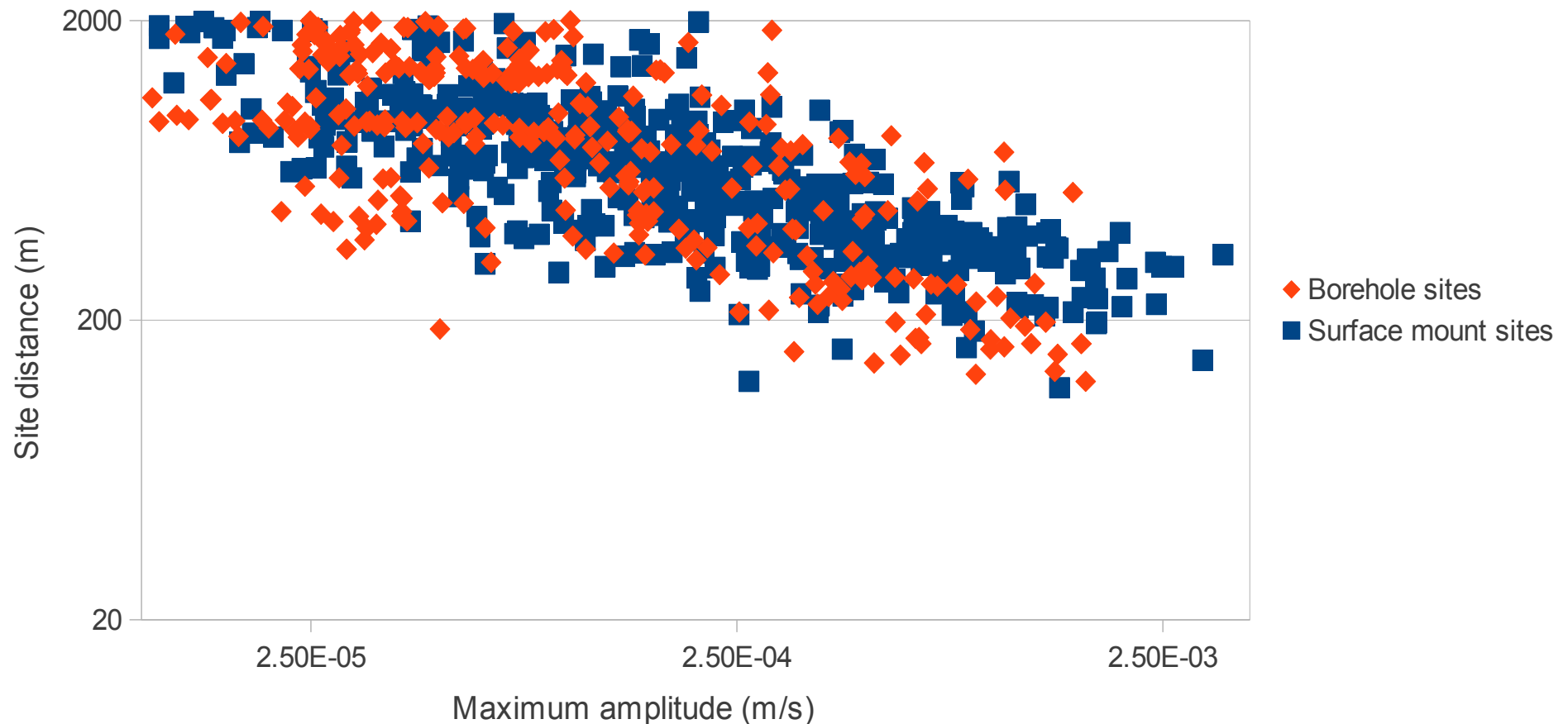
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Case study 1 – Maximum amplitude vs site distance ($-0.5 < m < 0.0$)

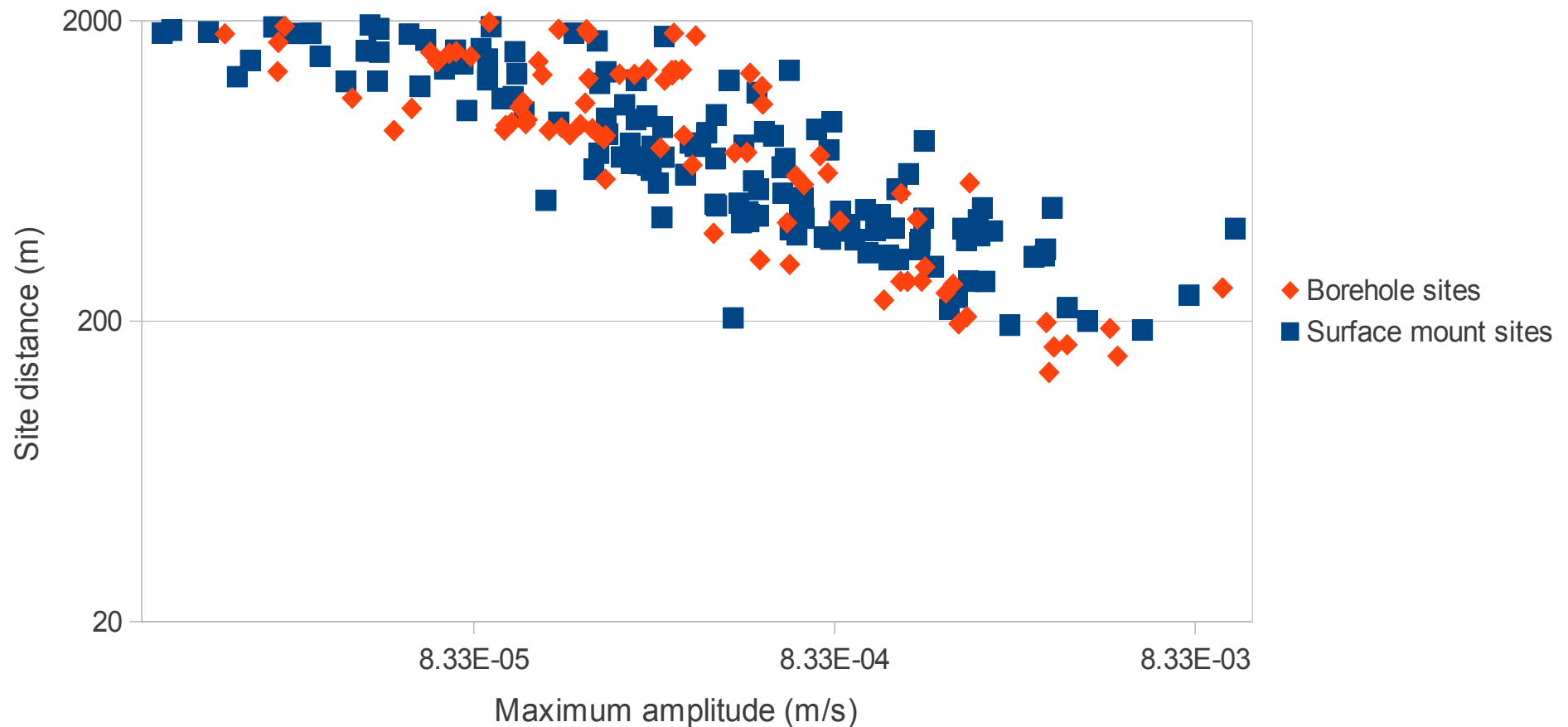
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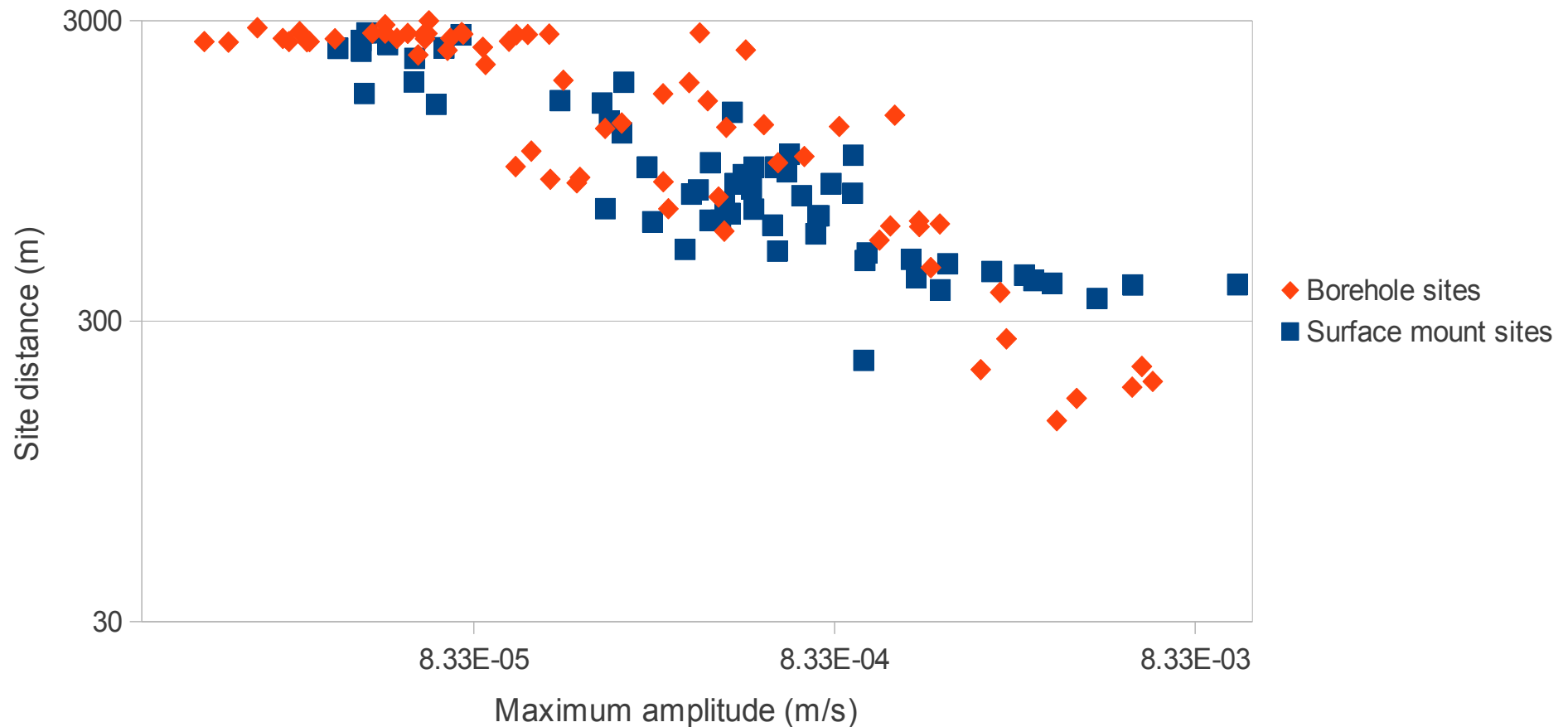
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Case study 1 – Maximum amplitude vs site distance ($0.5 < m < 1.0$)

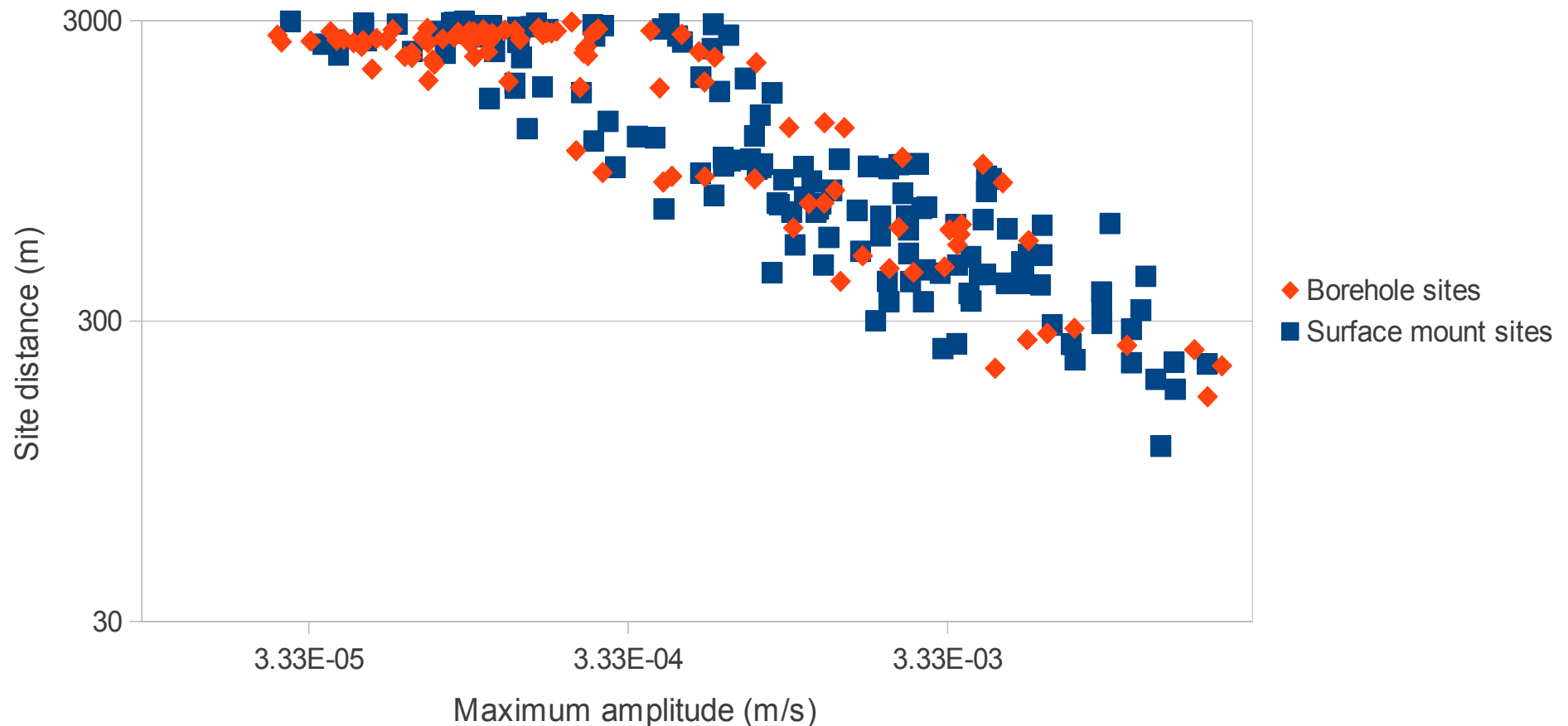
Comparison of borehole and surface mount sites -
Maximum amplitude versus site distance for events $0.5 < m < 1.0$





Case study 1 – Maximum amplitude vs site distance ($m > 1.5$)

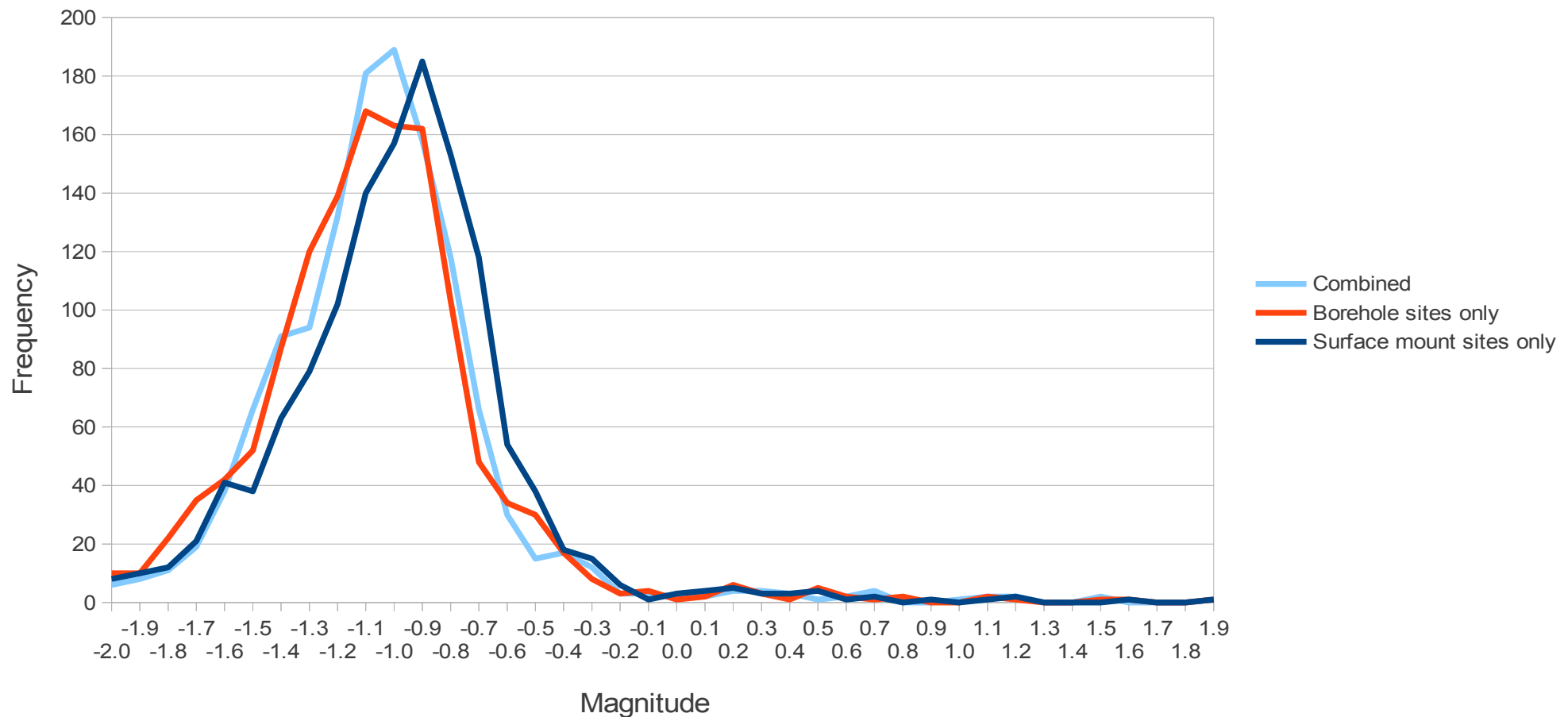
Comparison of borehole and surface mount sites -
Maximum amplitude versus site distance for events $m > 1.0$





Case study 1 - Comparison of the magnitude calculations of the different site types

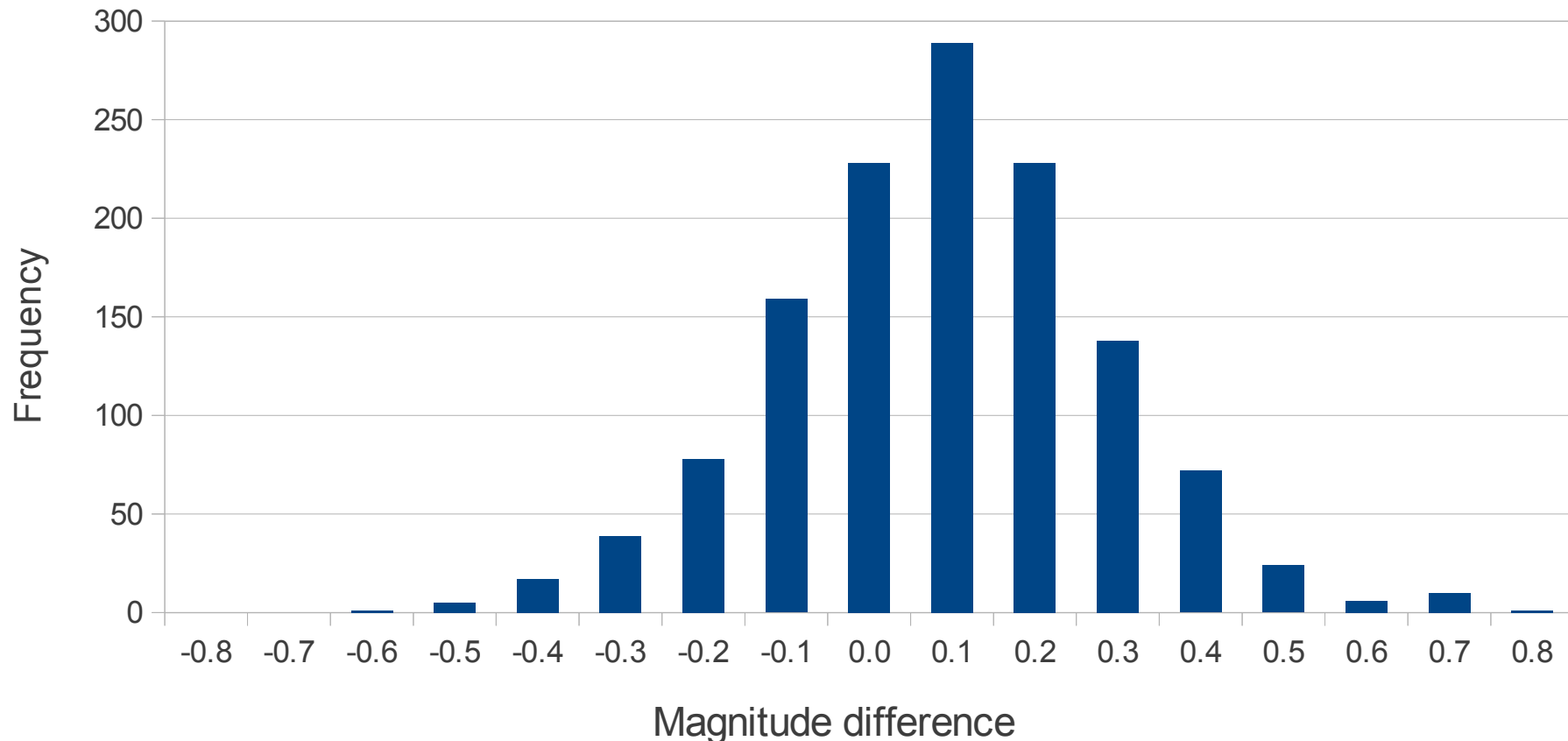
Comparison in the magnitudes using the different sites





Case study 1 - The difference in the magnitude calculations

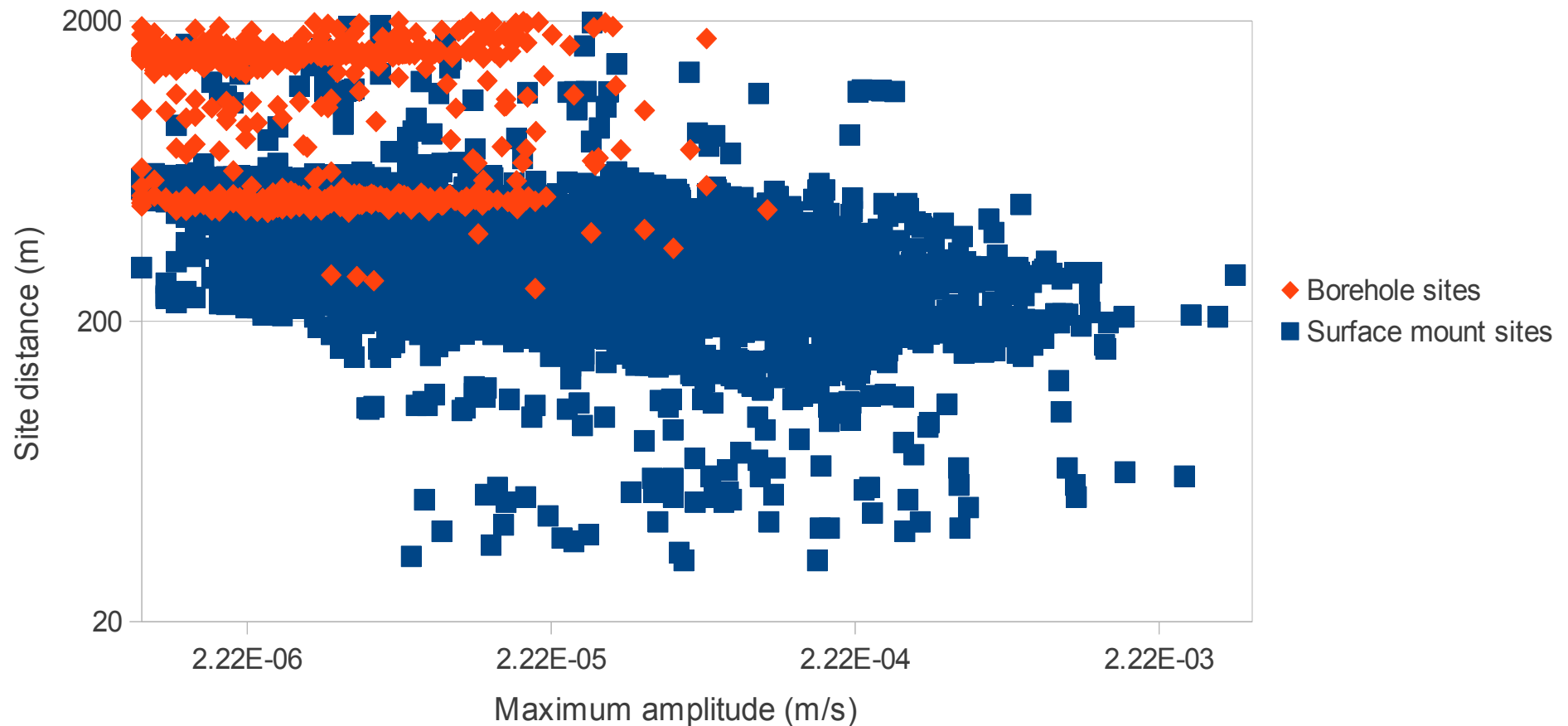
The difference in the magnitude calculation of the different site types





Case study 2 – Maximum amplitude vs site distance (m < -1.0)

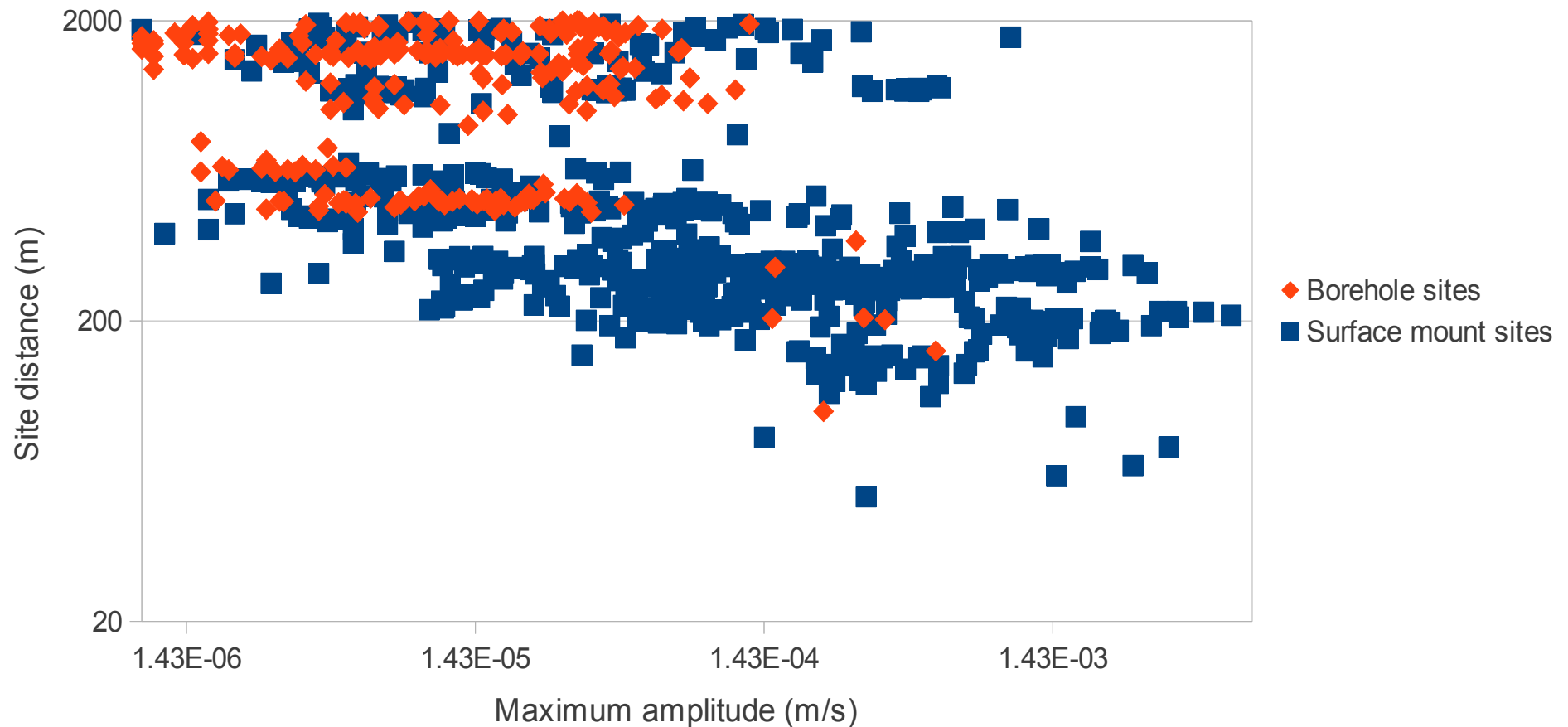
Comparison of borehole and surface mount sites -
Maximum amplitude versus site distance for events $m < -1.0$





Case study 2 – Maximum amplitude vs site distance ($-1.0 < m < -0.5$)

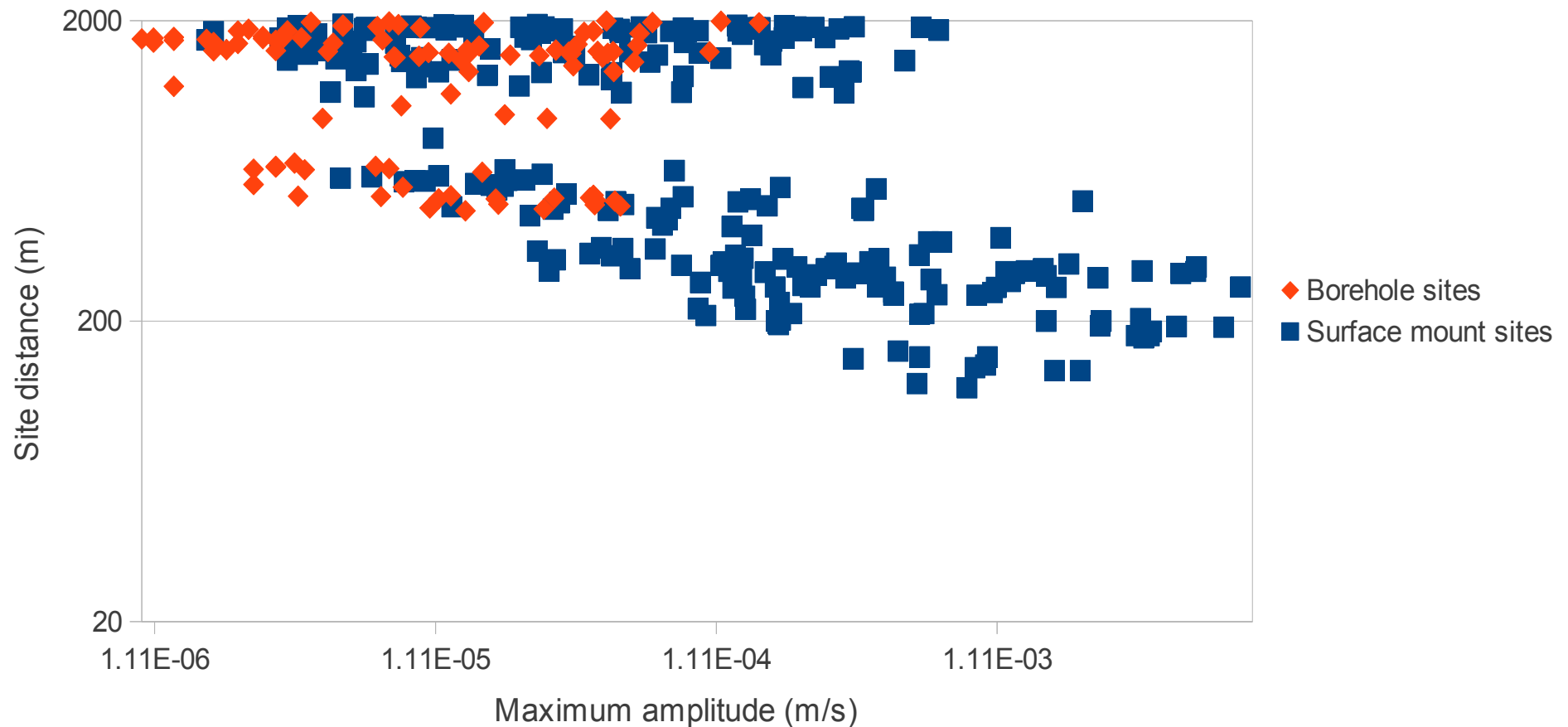
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Case study 2 – Maximum amplitude vs site distance ($-0.5 < m < 0.0$)

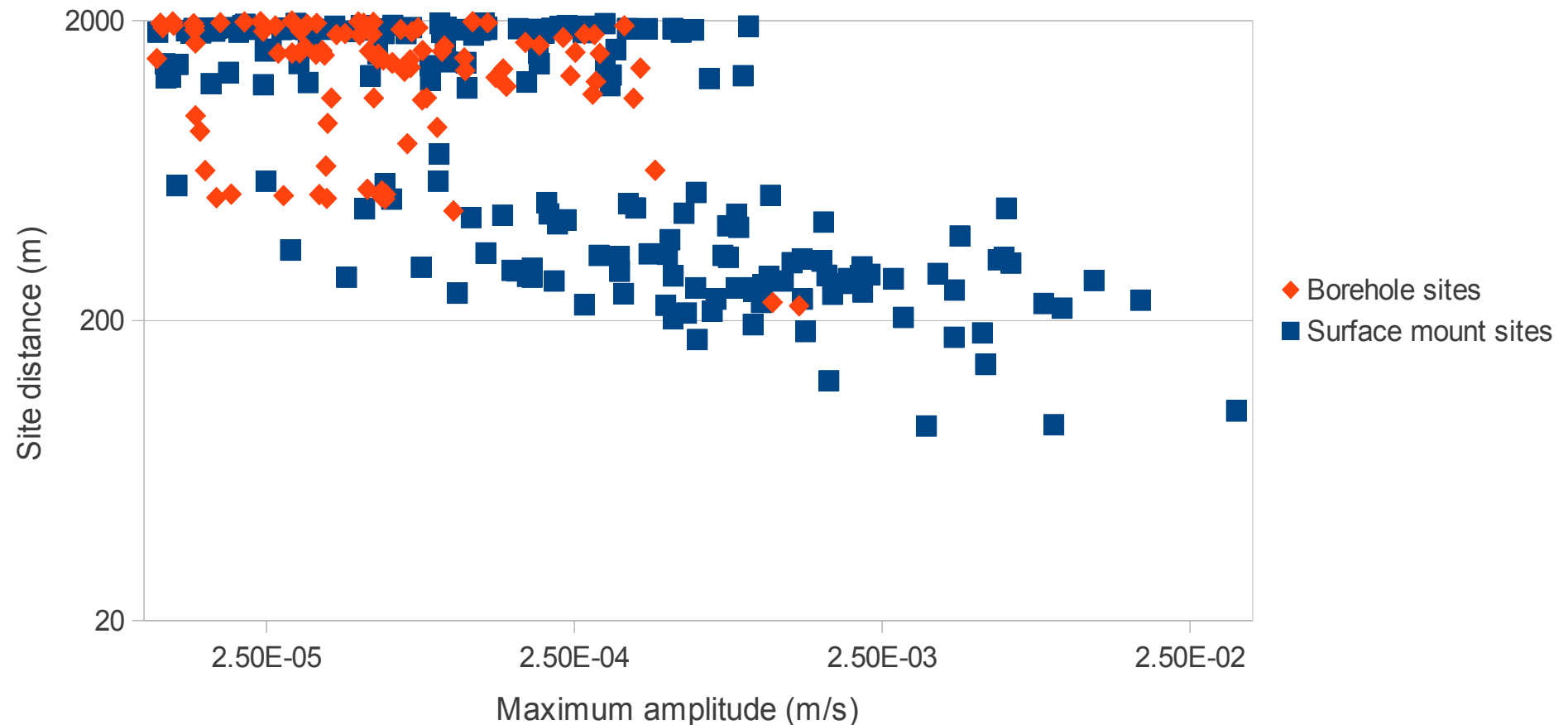
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Case study 2 – Maximum amplitude vs site distance ($0.0 < m < 0.5$)

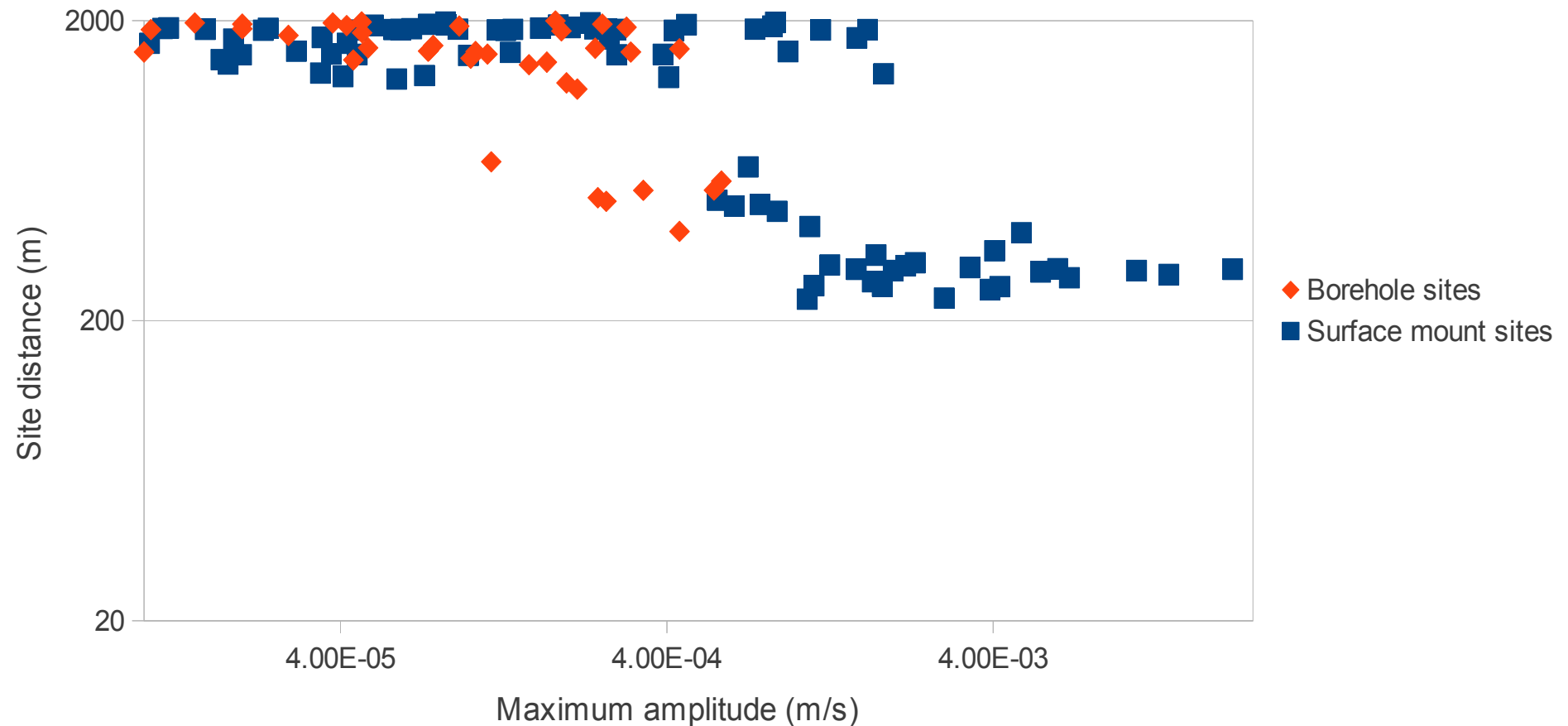
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Maximum amplitude versus site distance for events $0 < m < 0.5$





Case study 2 – Maximum amplitude vs site distance ($0.5 < m < 1.0$)

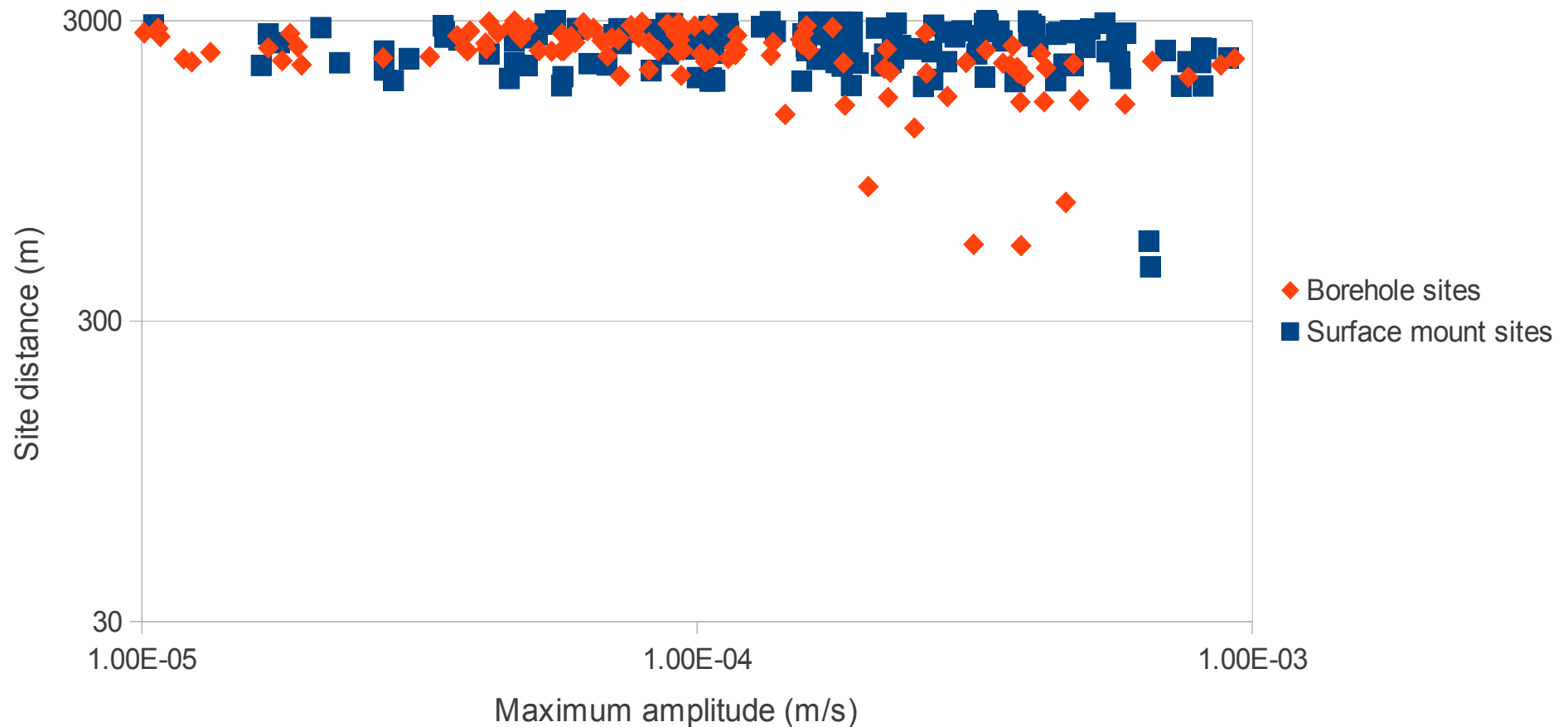
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Case study 2 – Maximum amplitude vs site distance ($1.0 < m < 1.5$)

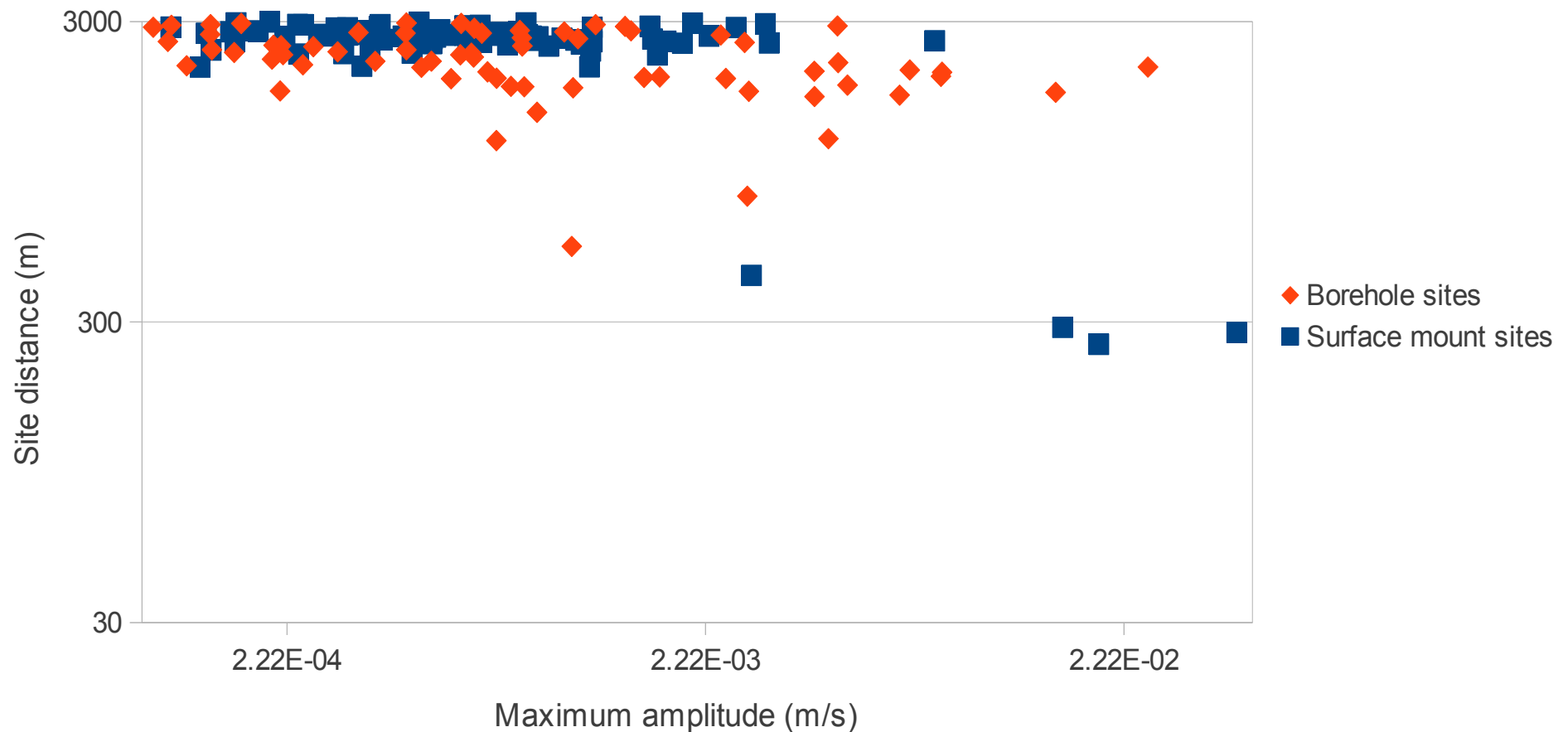
Comparison of borehole and surface mount sites -
Maximum amplitude versus site distance for events $1.0 < m < 1.5$





Case study 2 – Maximum amplitude vs site distance ($m > 1.5$)

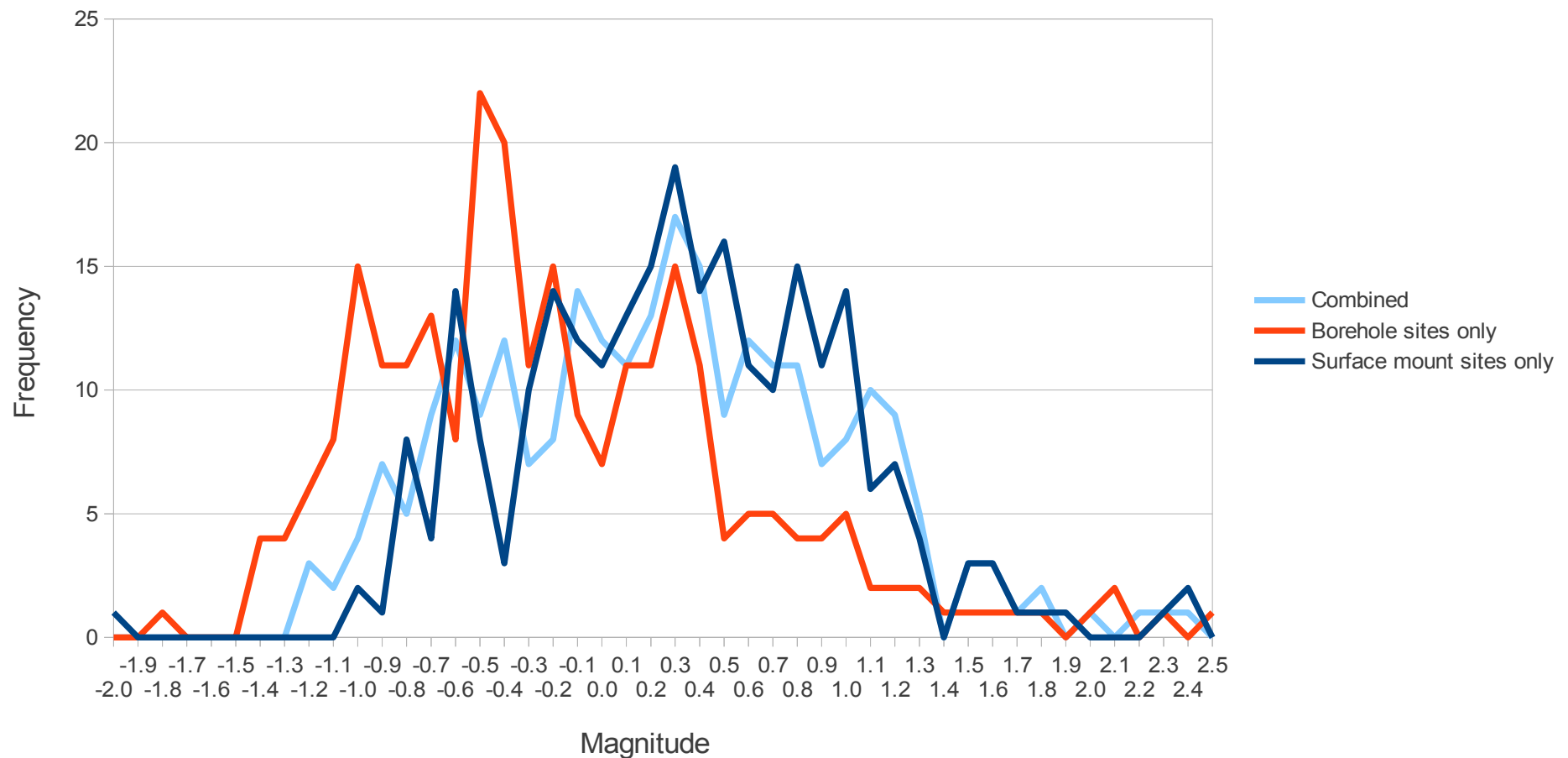
Comparison of borehole and surface mount sites -
Maximum amplitude versus site distance for events $m > 1.5$





Case study 2 - Comparison of the magnitude calculations of the different site types

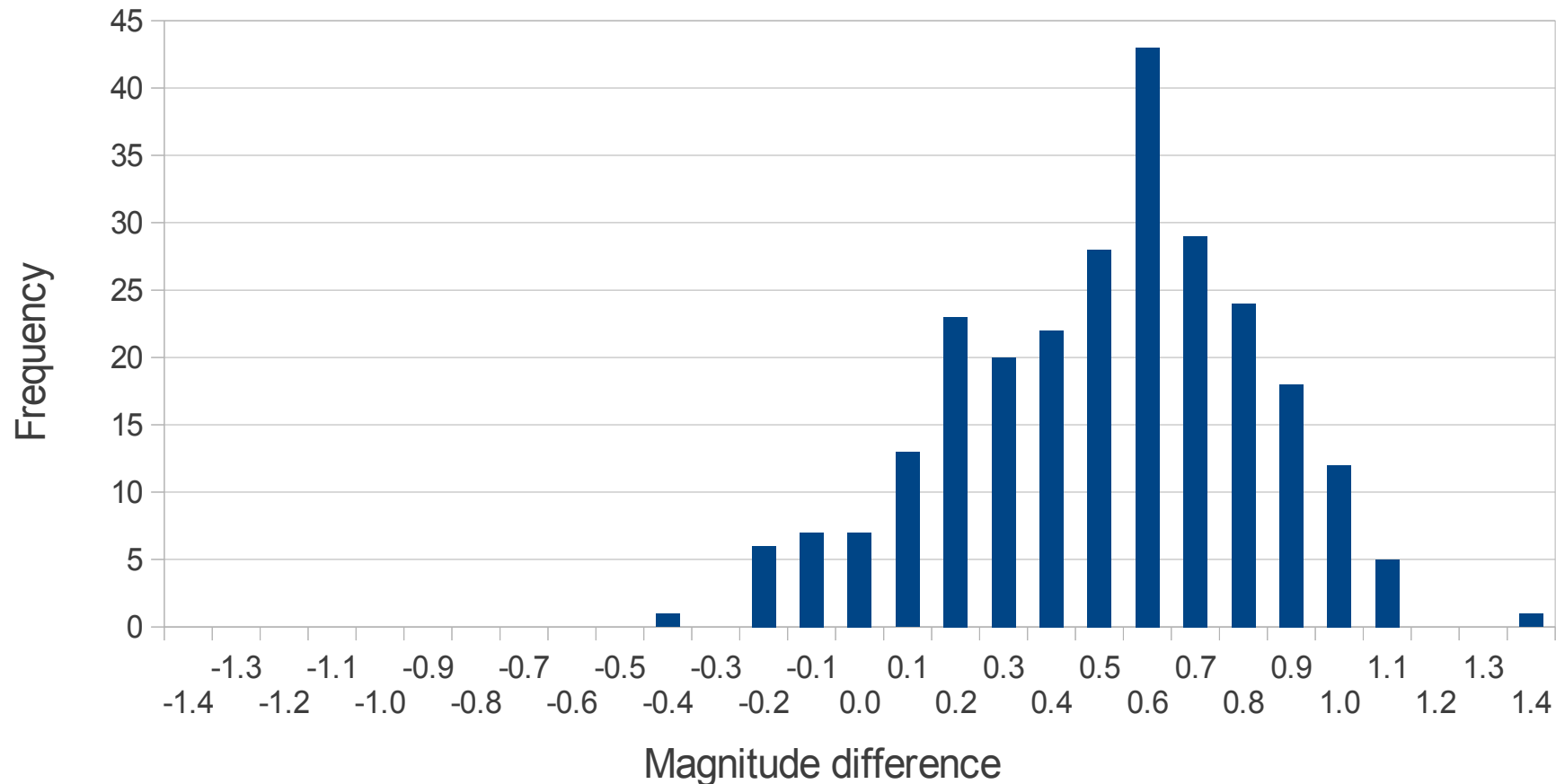
Comparison in the magnitudes using the different sites





Case study 2 - The difference in the magnitude calculations

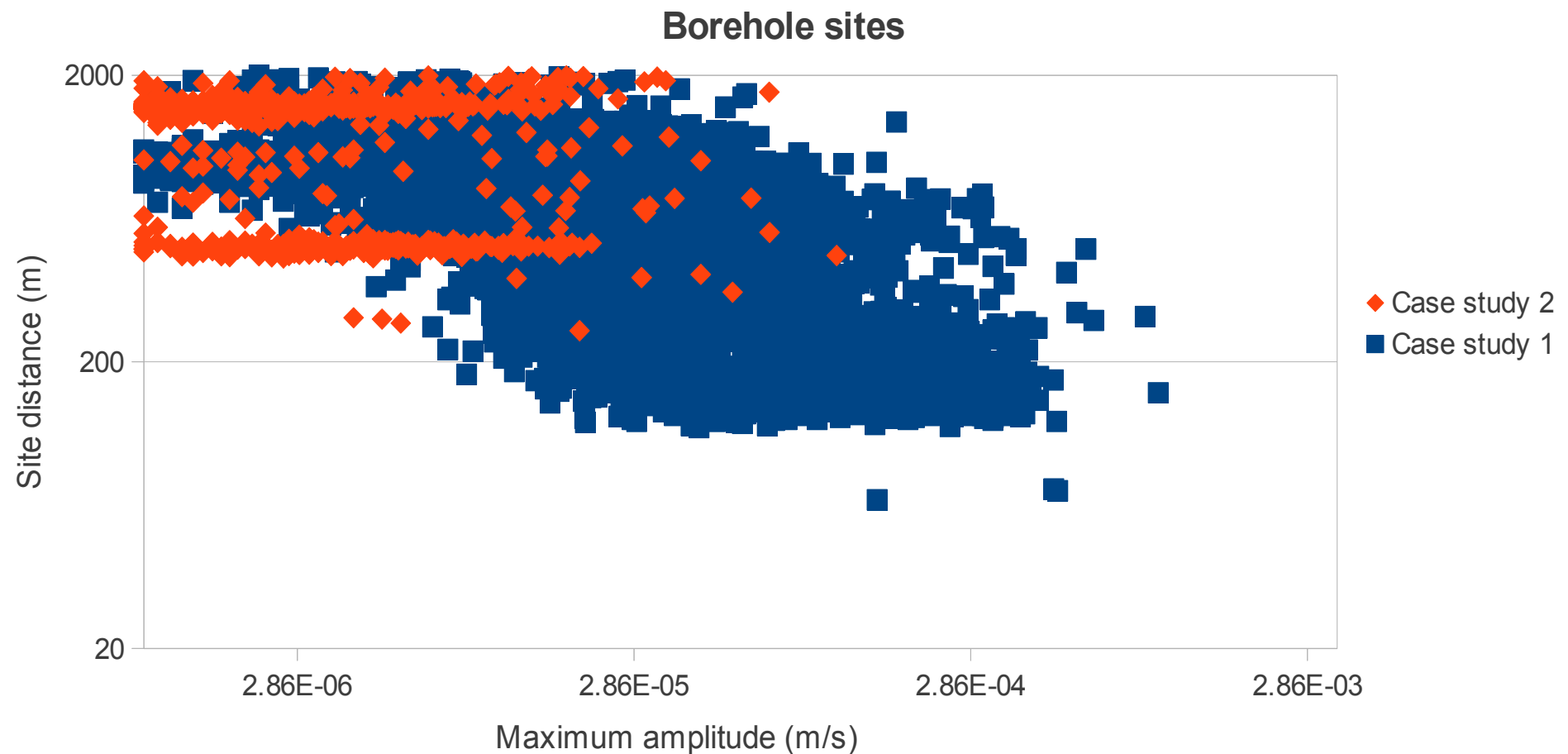
The difference in the magnitude calculation of the different site types





Comparison of the maximum amplitudes of the two case studies

Comparison of the maximum amplitudes of the two case studies for events $m < -1.0$

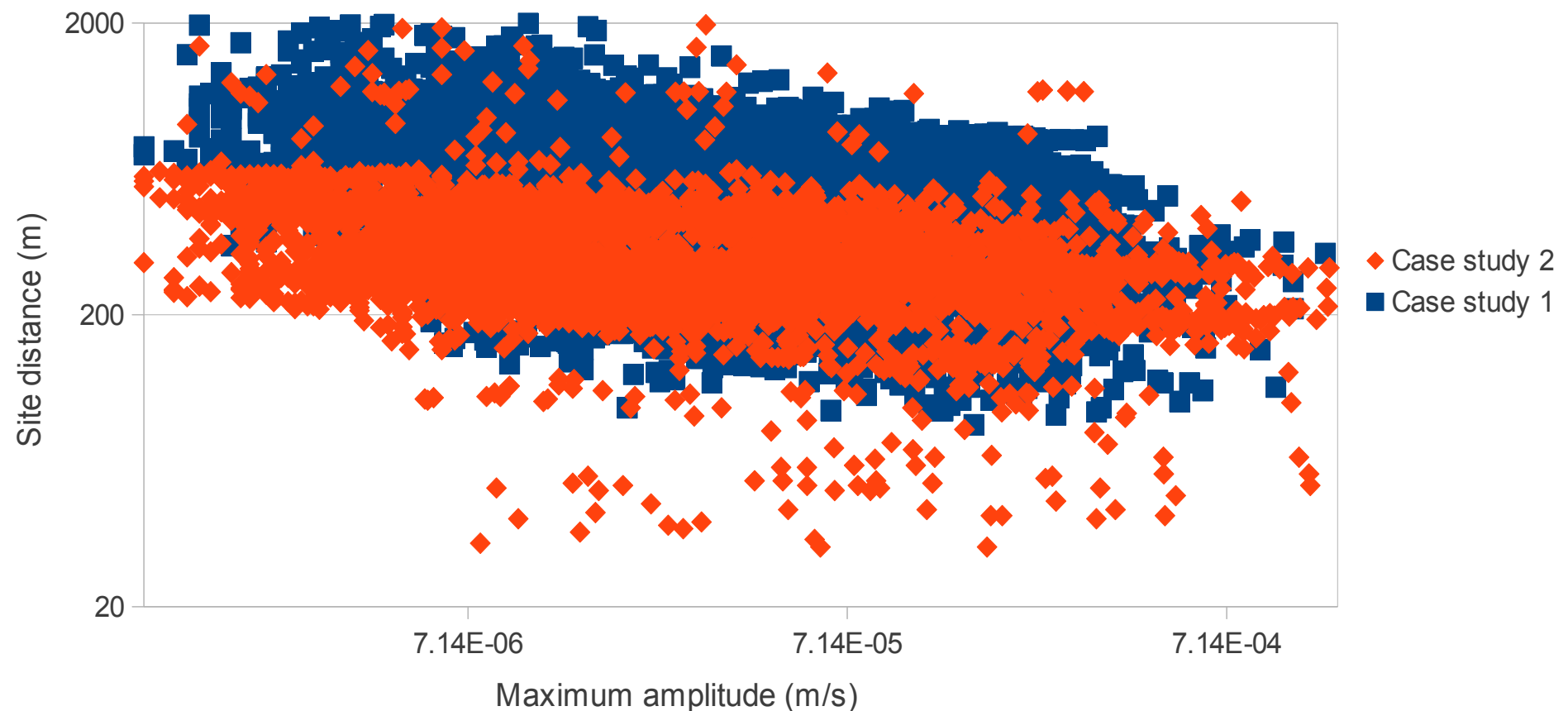




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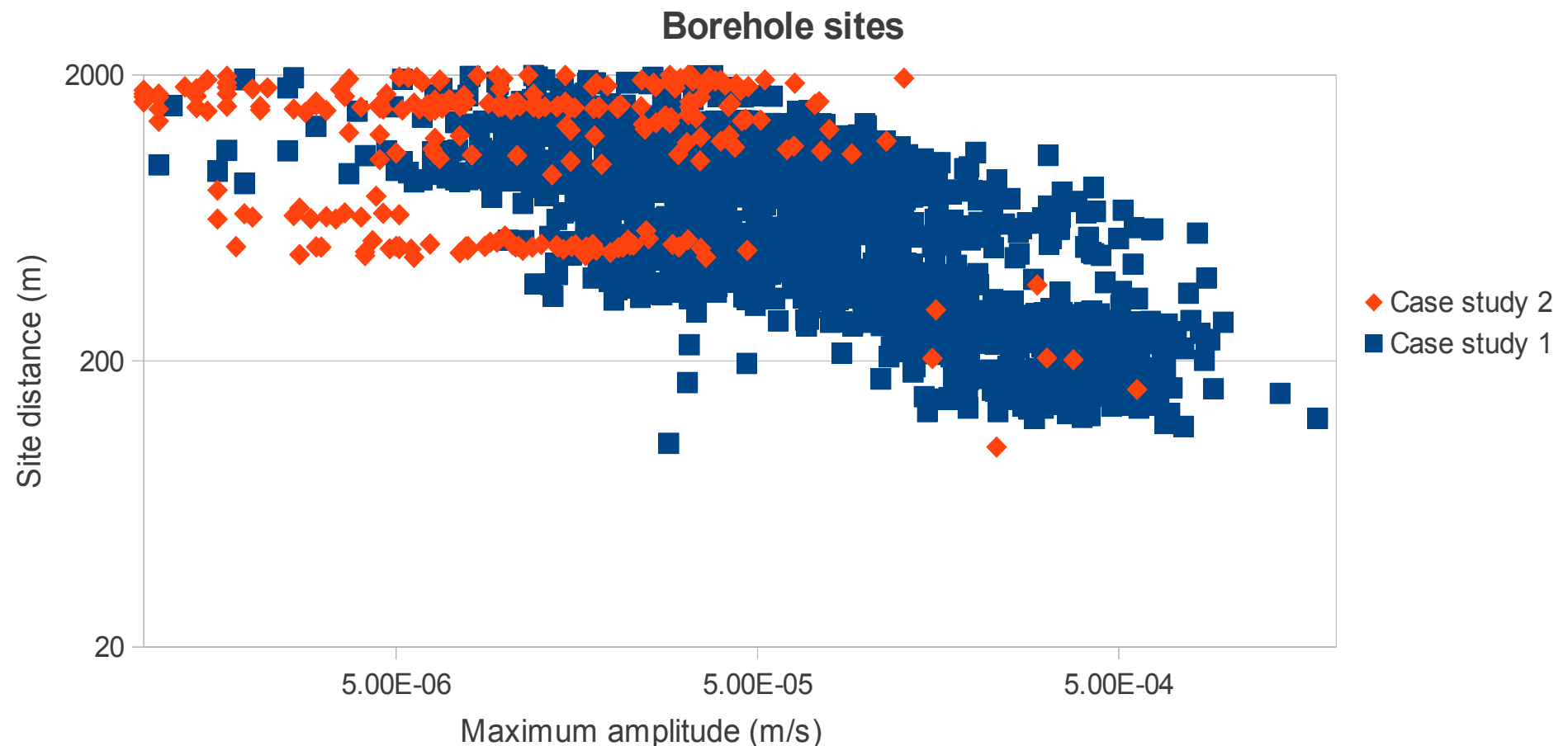
Surface mount sites





Comparison of the maximum amplitudes of the two case studies

Comparison of the maximum amplitude of the two case studies
for events $-1.0 < m < -0.5$

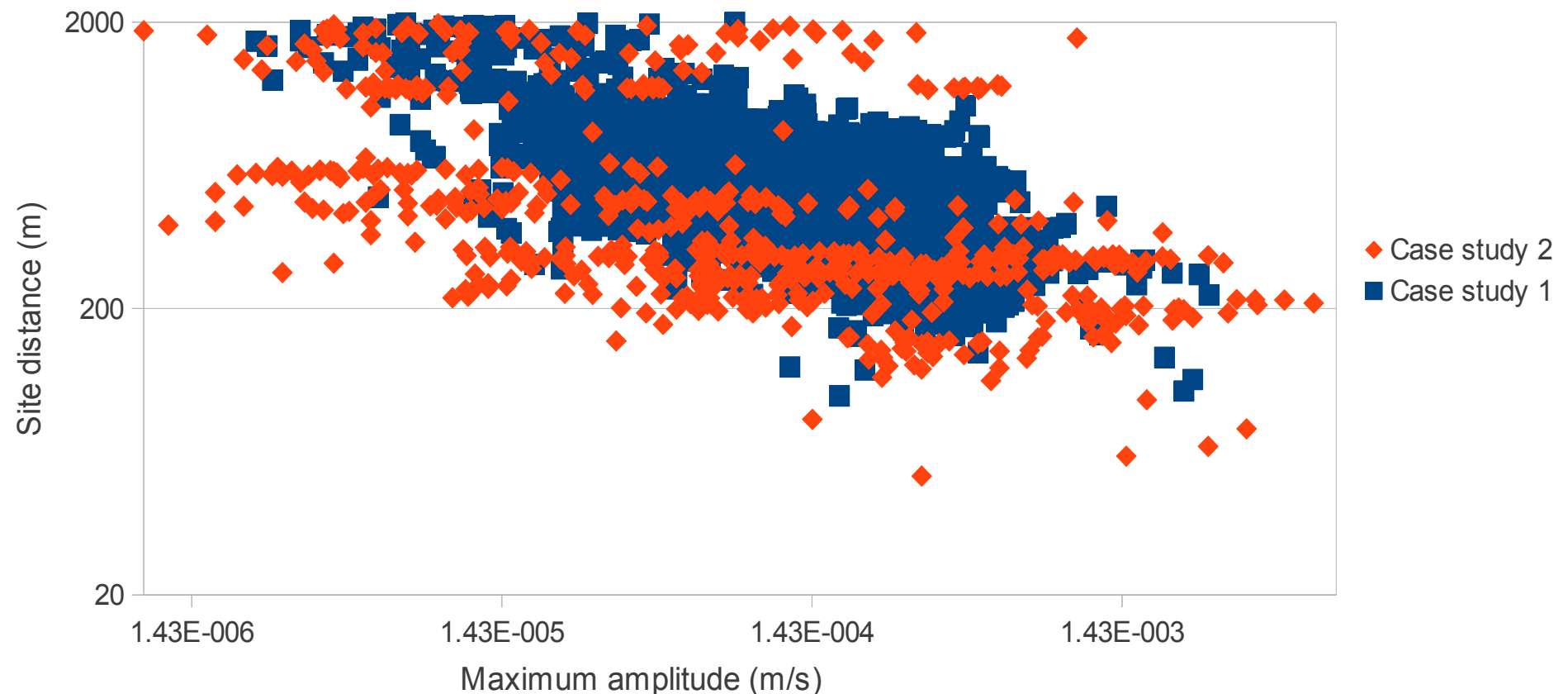




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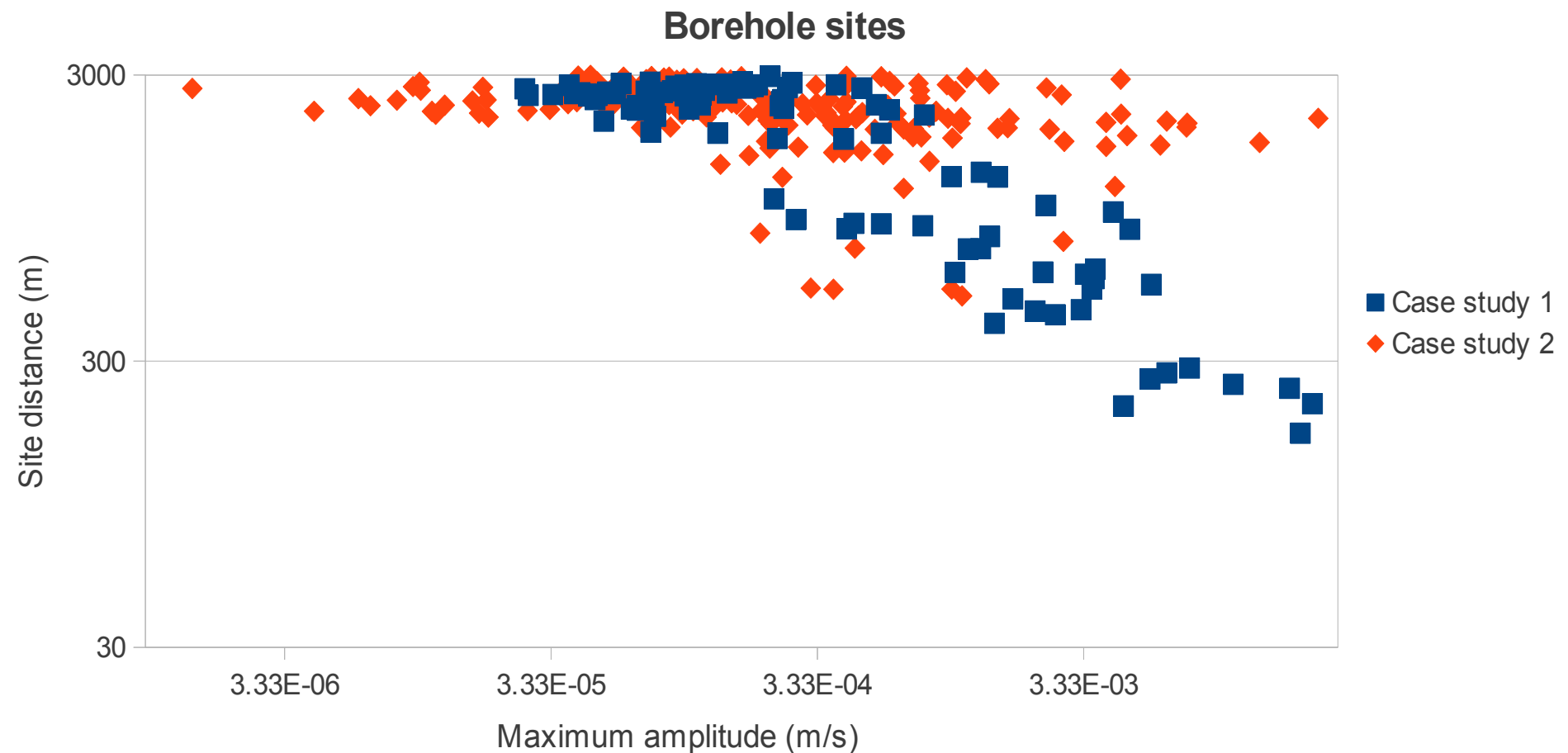
Surface mount sites





Comparison of the maximum amplitudes of the two case studies

Comparison of the maximum amplitude of the two case studies for events $m > 1.0$

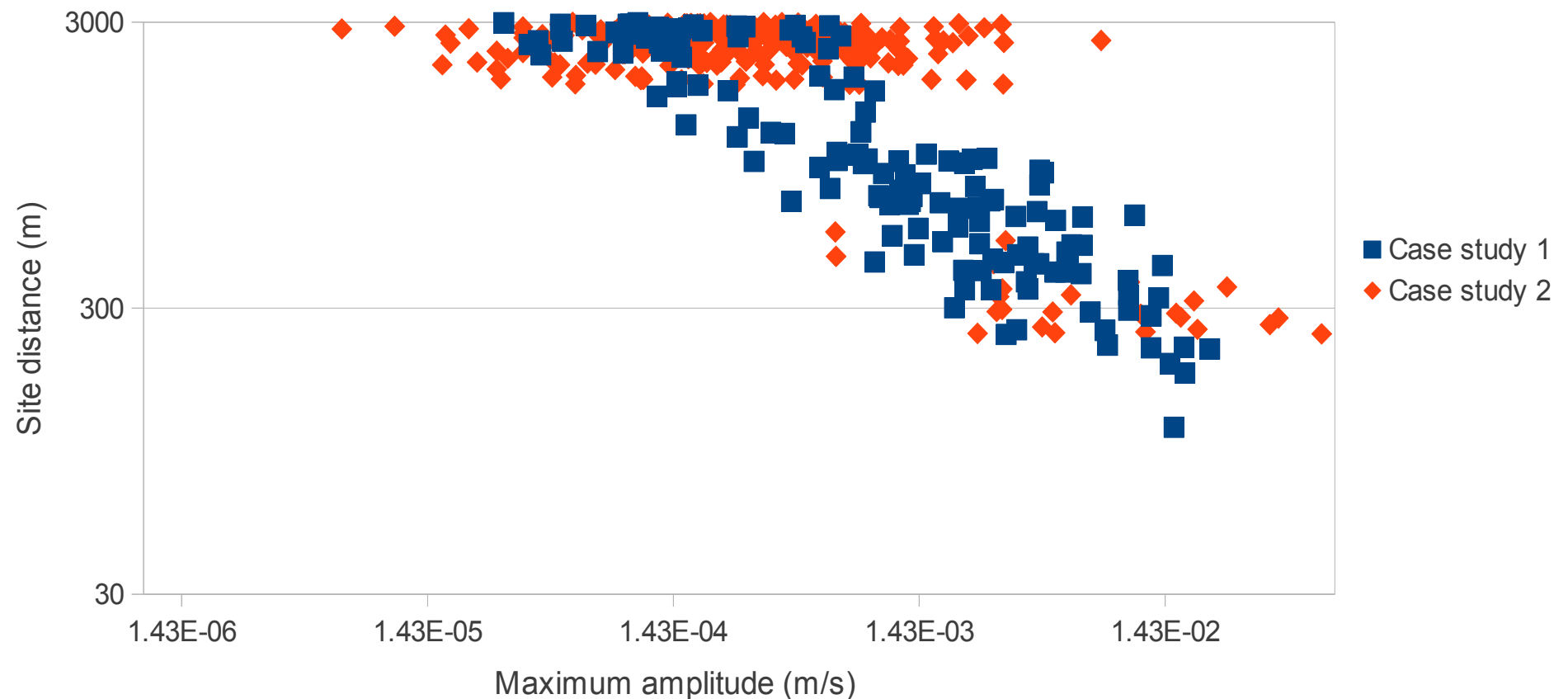




Comparison of the maximum amplitudes of the two case studies

Comparison of the maximum amplitude of the two case studies for events $m > 1.0$

Surface mount sites





Conclusion

- For the two case studies, surface mount sensors gave higher amplitudes than the borehole sensors – particularly for smaller events and for sites closer to the source.
- Case study 1 showed a small difference in the magnitude when calculated with the different sensor types.
- Case study 2 showed a significant difference in the magnitude when calculated with the different sensor types.
- Case study 1's borehole sensors had a higher amplitude than case study 2 – possibly due to poor installation of the boreholes.
- Concern is that events recorded in areas of the mine which are covered predominantly by surface mount sensors may have over-estimated source parameters.



Future investigation

- Do different installation practices of surface mount sensors have an influence on the performance of the surface mount sensors?
- Will the surface mount sensors affect location due to the more complex coda in the waveforms?