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Supplement of

Machine learning prediction of the mass and the velocity of controlled single-block rockfalls from the seismic waves they generate

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Attenuation of the amplitude of seismic waves for each impact of Block #1 :

Figure S1: a) Seismic signals recorded at each geophone for the launch of Block #1 ; b) Maximum envelope amplitude as a function of the distance and smoothed FFT spectrum for each impact and each station. The colours corresponds to the colour of the seismic signals on Figure S1a and geophones on Figure 1.

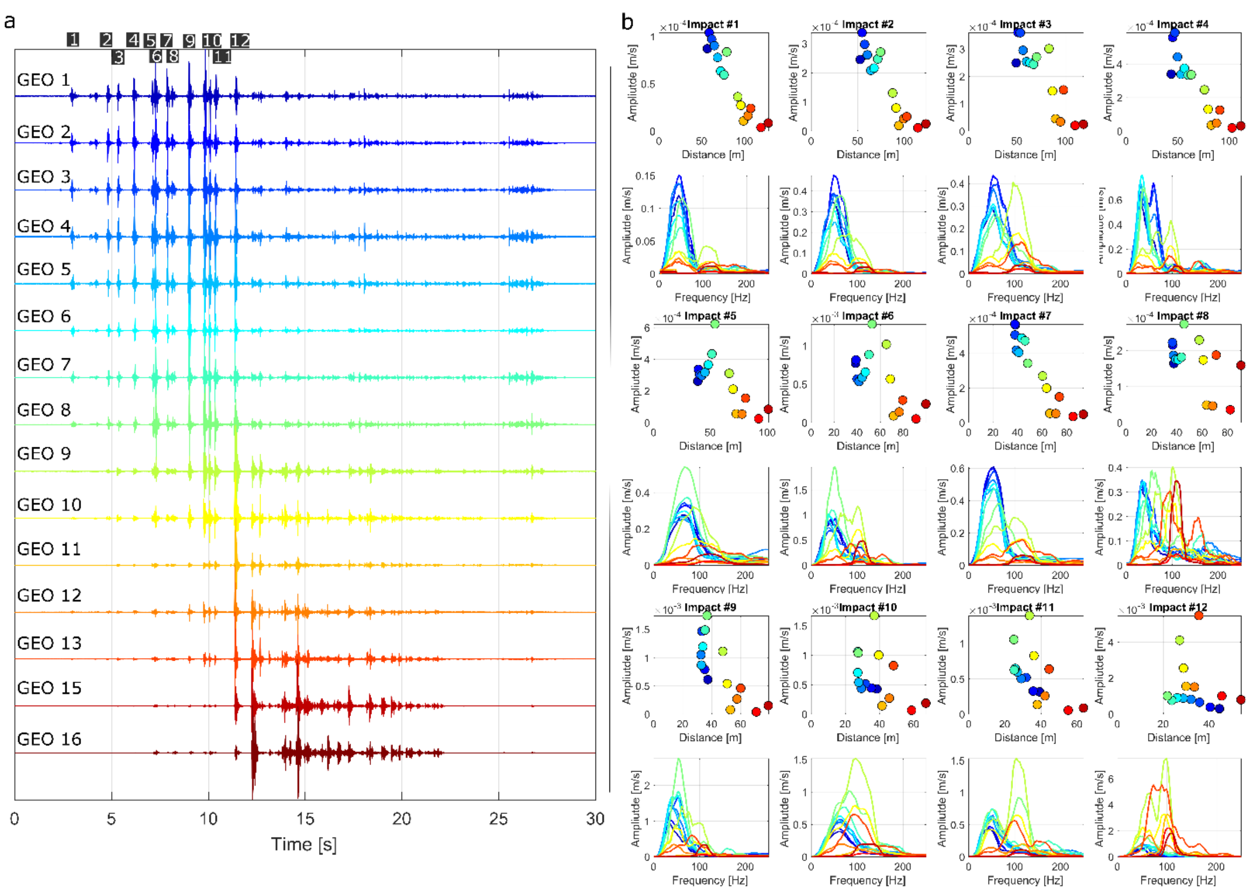

Figure S1 shows the seismic signals and the attenuation of the amplitude of seismic waves generated by each impact for the launch of the Block #1. Thanks to the trajectory reconstruction we can determine the distance between each impact and each geophone. Then we can compute attenuation models and find the one that better explain the observed decay of amplitude with distance. Determining an adequate attenuation model is critical to determine the parameters (amplitude and energy) at the source which are then compared to dynamic parameters.

We tested two simple models, one for surface wave (Equation S1) and one for body wave (Equation S2), as well as the possibility of a simple linear attenuation of the amplitude with distance (Equation S3) :

$$A(r) = A0\frac{e^{-\beta r}}{r}\ (Eq.S1)$$

$$A(r) = A0\frac{e^{-\beta r}}{\sqrt{r}}\ \ (Eq.S2)$$

$$A(r) = \frac{A0}{r}\ (Eq.S3)$$

With r the distance between the impact and the geophones, $A0$ the amplitude at the source and β the anelastic attenuation factor.

For each model we computed the regression line and assess the quality of the regression by computing R2 (Table S1). Figure S1b and the table shows that there is no effect of the distance on the best fit of the amplitude as a function of the distance. For each impact the model that allow to best explain the link between the amplitude and the distance between the impact and the sensors is the model 1, which assume body-waves propagation. The best fit is always observed for the body-wave model. The model 2, assuming surface waves propagation, yields also high R^2 values but lower than from model 1. Nevertheless, in this context, at those distances of the impacts (near-field) and for single impacts, we demonstrate that a body-wave based attenuation model is better suited to compute source parameters.

Attenuation also impacts the frequency content of the seismic signal recorded at the different sensors (Figure S1b). Classically we observe a stronger attenuation of the higher frequency wave with distance., i.e. a loss of the high frequency seismic signal with distance. However, in this case we observe in some instances that the peak frequency is very high for signal recorded at distant stations (e.g. Fig. 3, impacts #1, #3, #4, #5, #8). Whether this is due to directivity or local effects of the site on which geophones have been deployed has to be investigated, but the fact that we observe those peaks constantly on the same geophones favours the latter assumption.

Impact #	Model 1	Model 2	Model 3
1	0,91	0,89	0,88
2	0,88	0,85	0,85
3	0,84	0,79	0,76
4	0,89	0,86	0,82
5	0,71	0,69	0,48
6	0,69	0,61	0,39
7	0,91	0,88	0,86
8	0,60	0,47	0,29
9	0,77	0,71	0,59
10	0,62	0,52	0,21
11	0,75	0,69	0,34
12	0,33	0,21	0,03

Table S1: R^2 from the regression with each model of the distance and amplitude data for each impact of the launch of Block #1