Using open-source software for extracting geomechanical parameters of a rock mass from 3DPC

Discontinuity Set Extractor and SMRTool

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Do we need to use 3D point clouds when assessing a rock mass?

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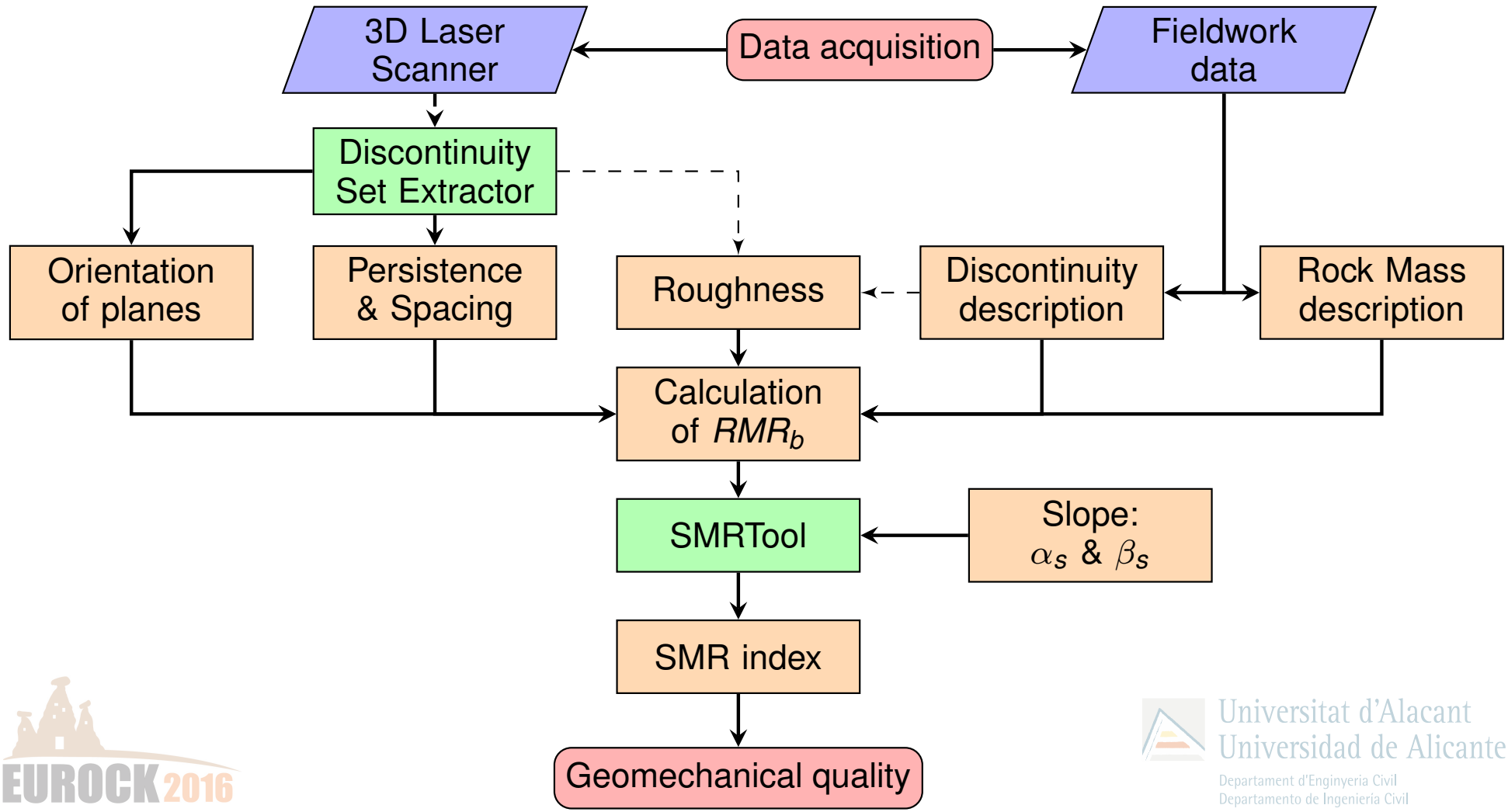
Flowchart


3D Laser Scanner
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Geomechanical quality

Discontinuity Set Extractor

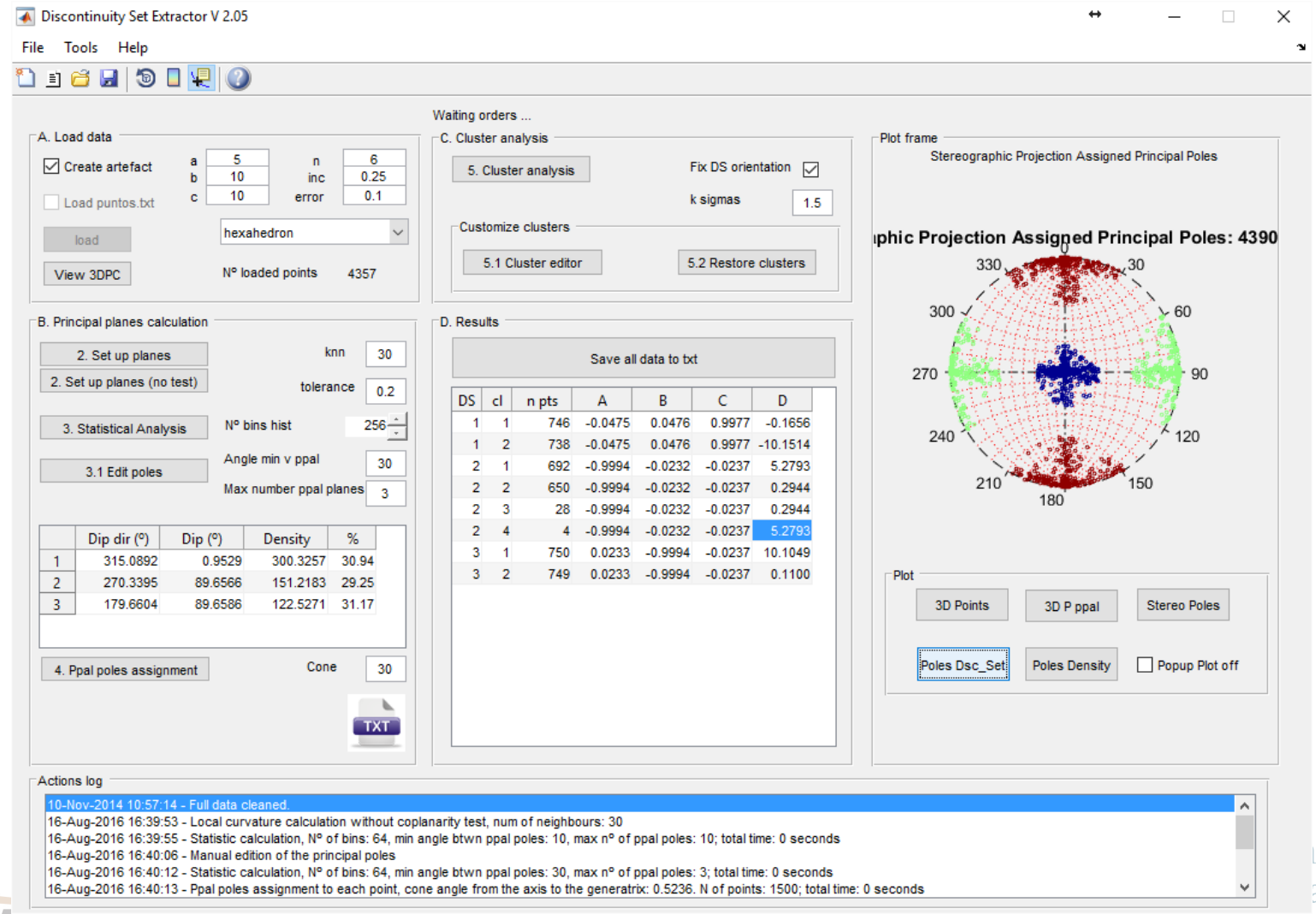

Figure. Discontinuity Set Extractor Software.

SMRTool

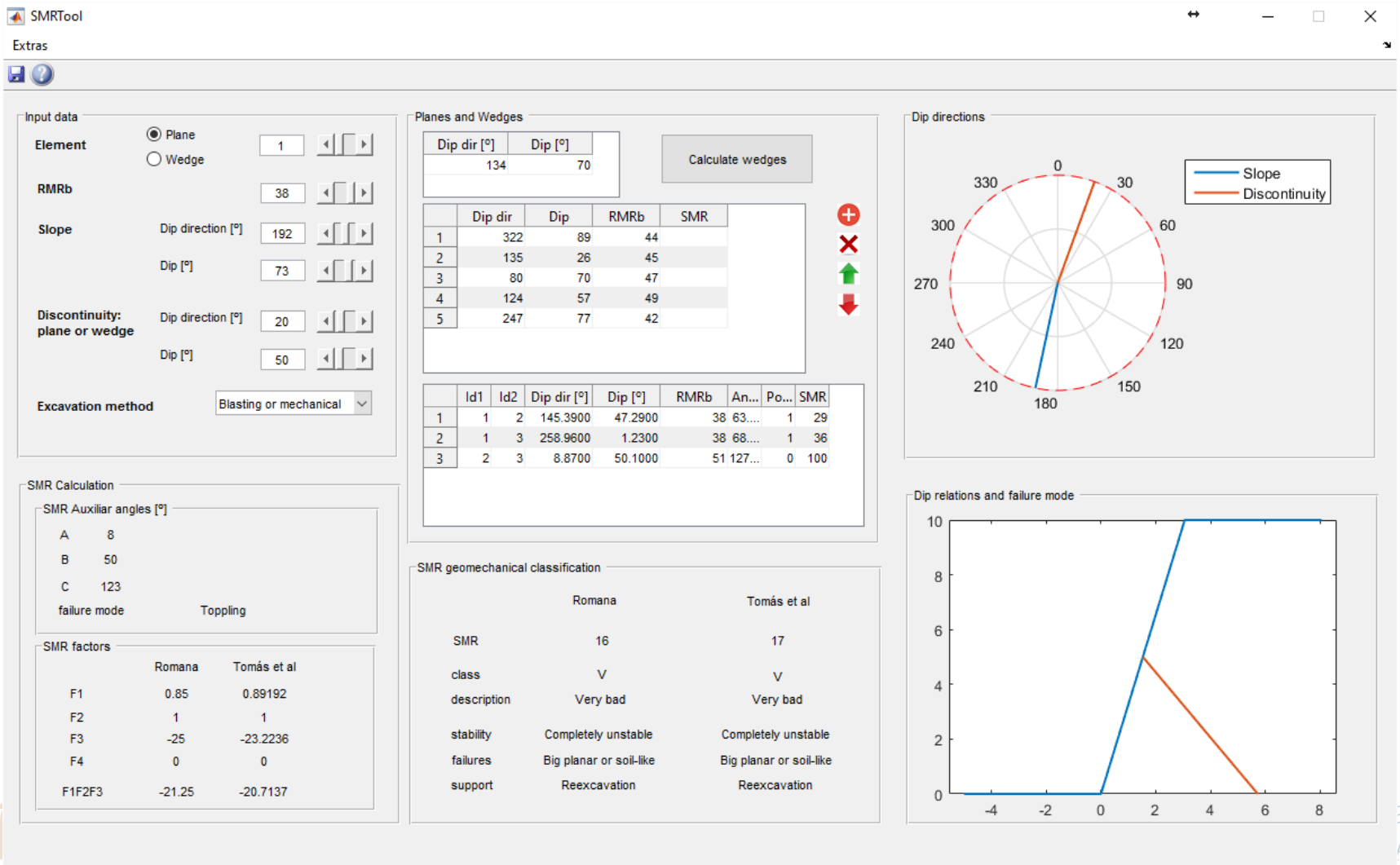

Figure. SMRTool Software.

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Description of the rock slope

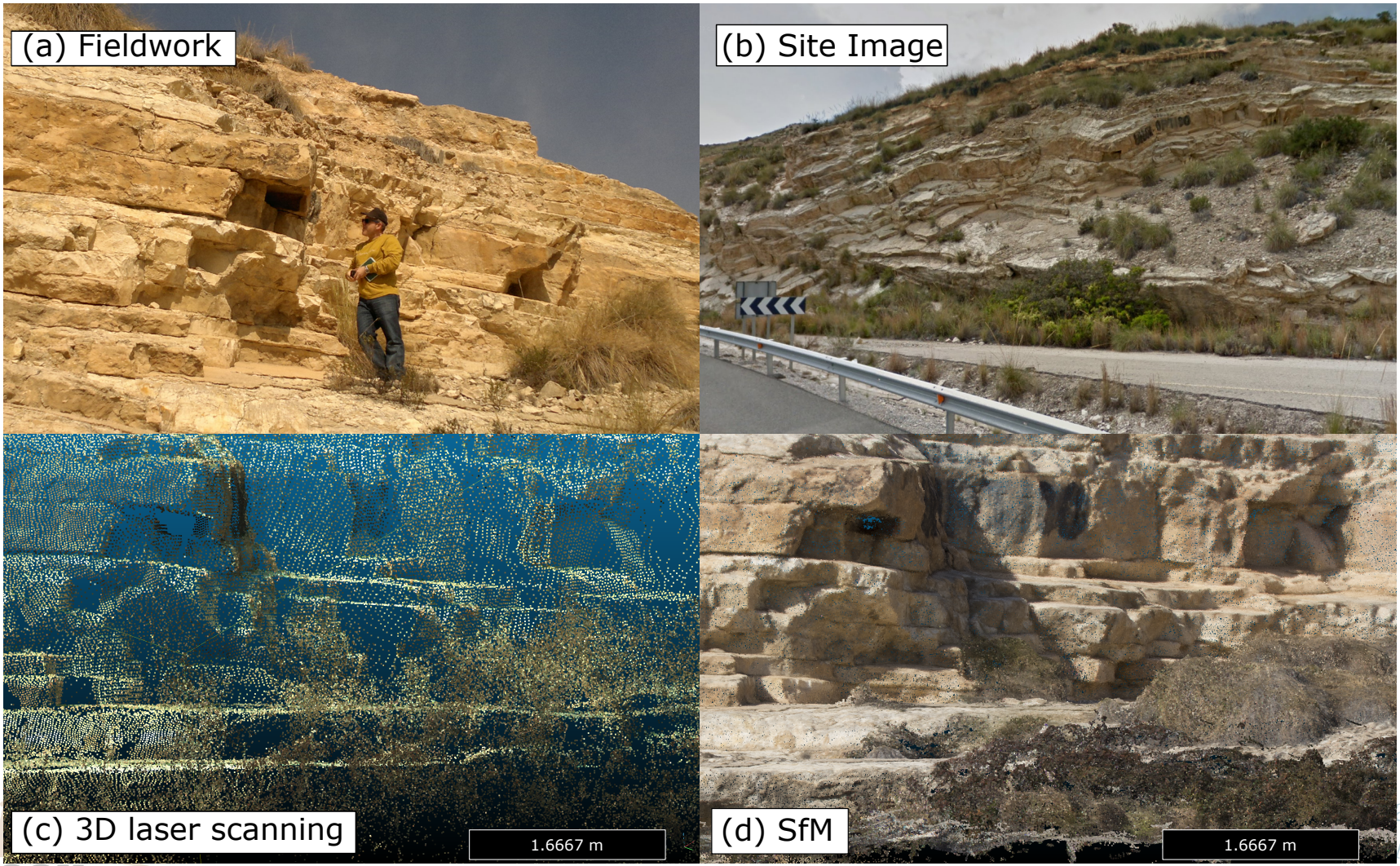

Figure. Sedimentary rock slope: limestones.

Extraction of the Discontinuity Sets

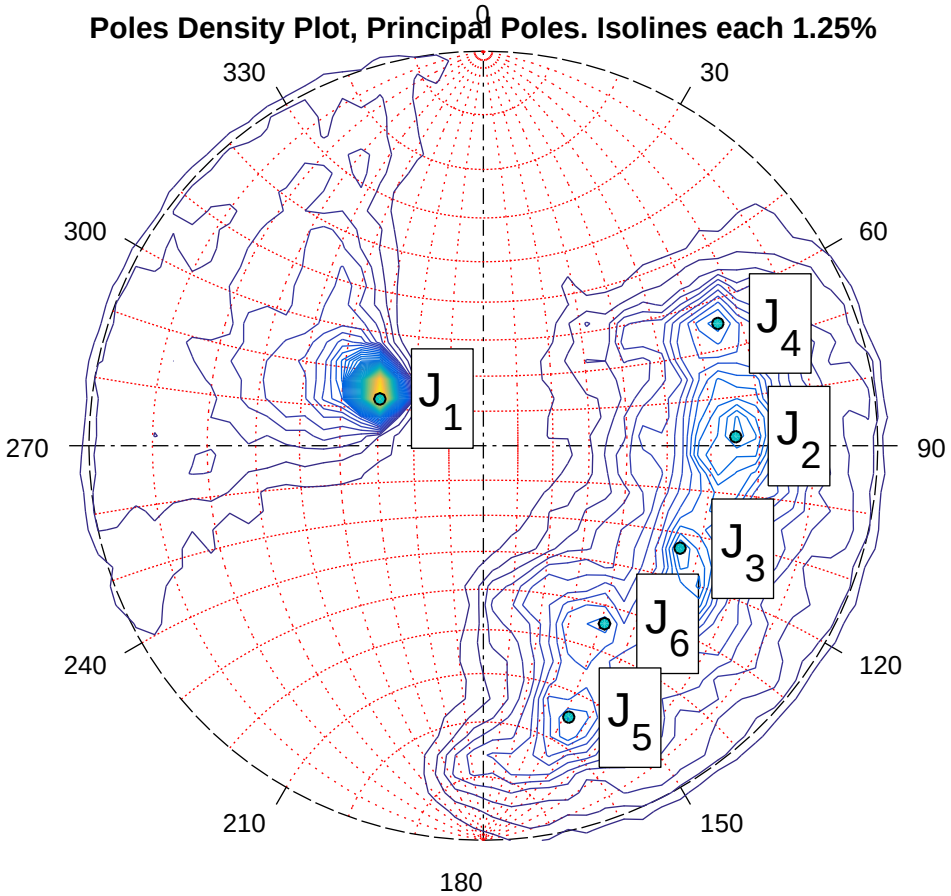

Figure. Density of the calculated poles. Figure generated using DSE software.

Discontinuity Set Extraction

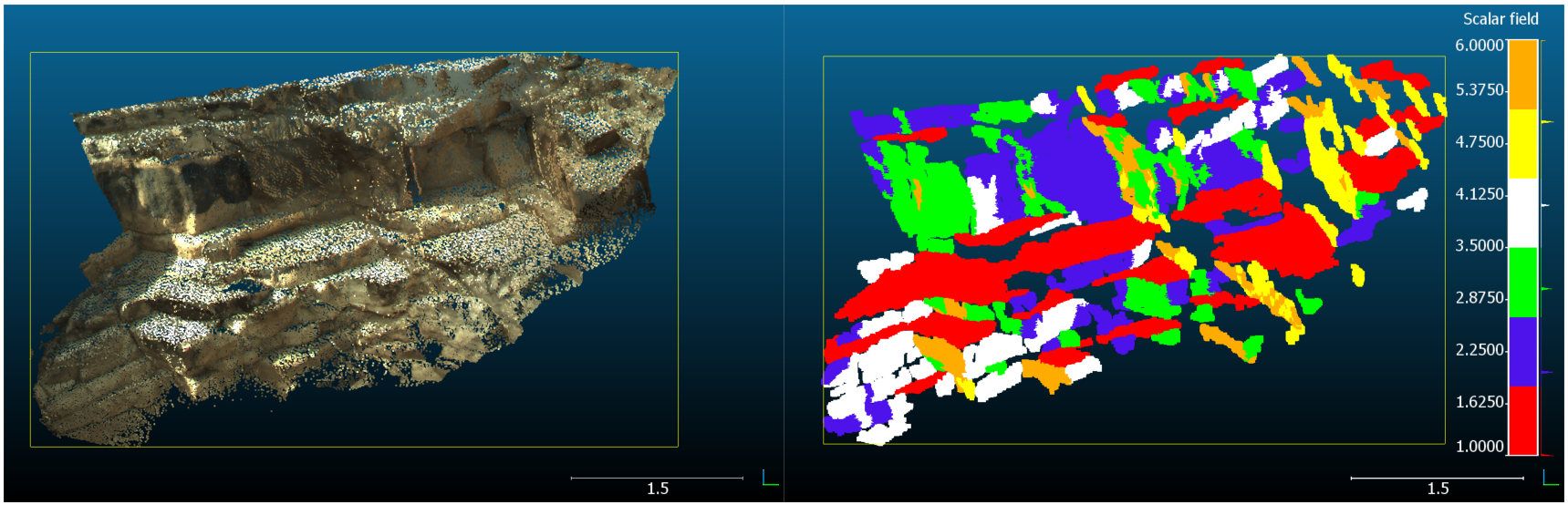

Figure. Classified point cloud.

Normal Spacing Analysis

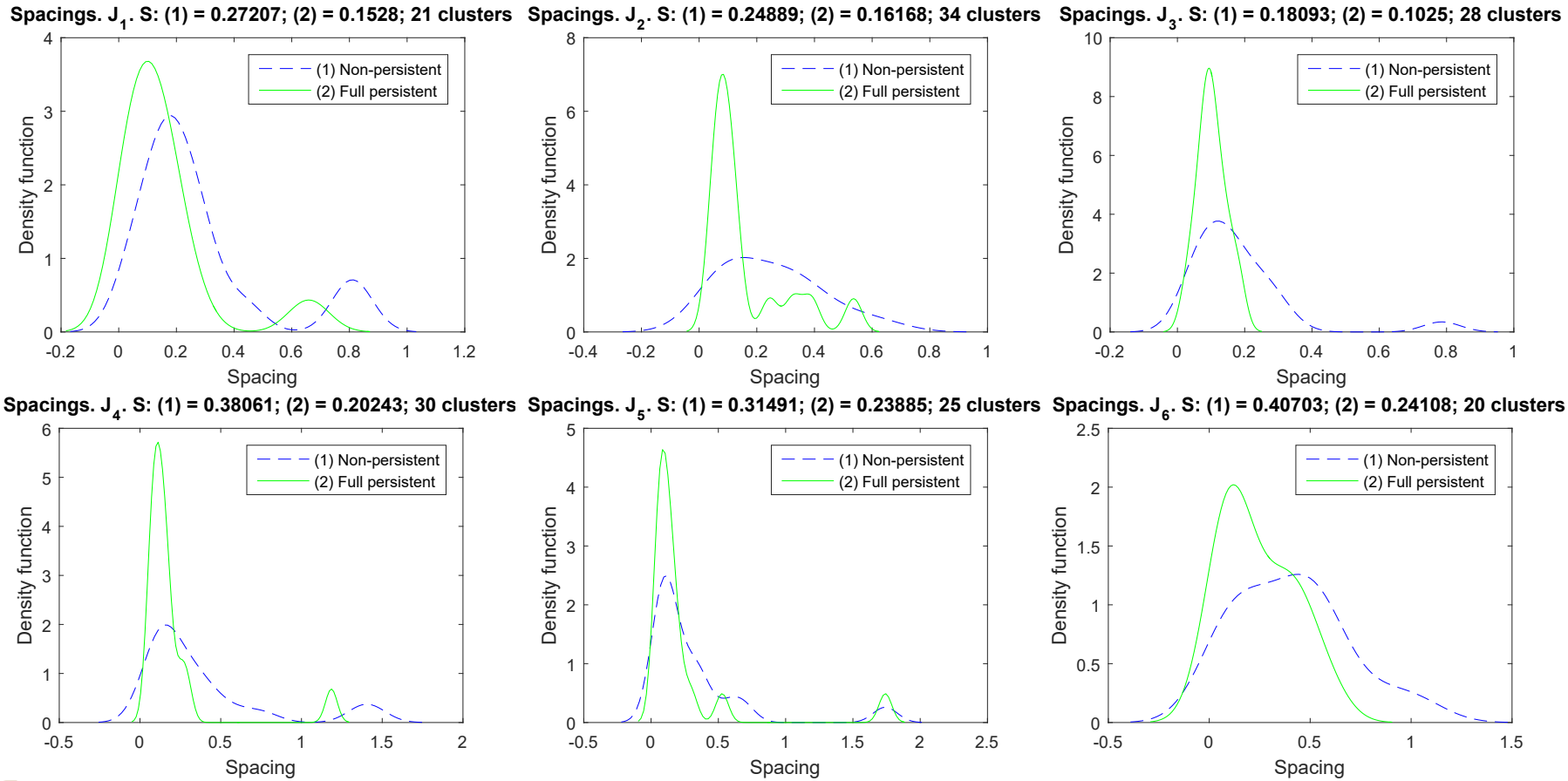

Figure. Density of the calculated poles.

Discontinuity Set Analysis

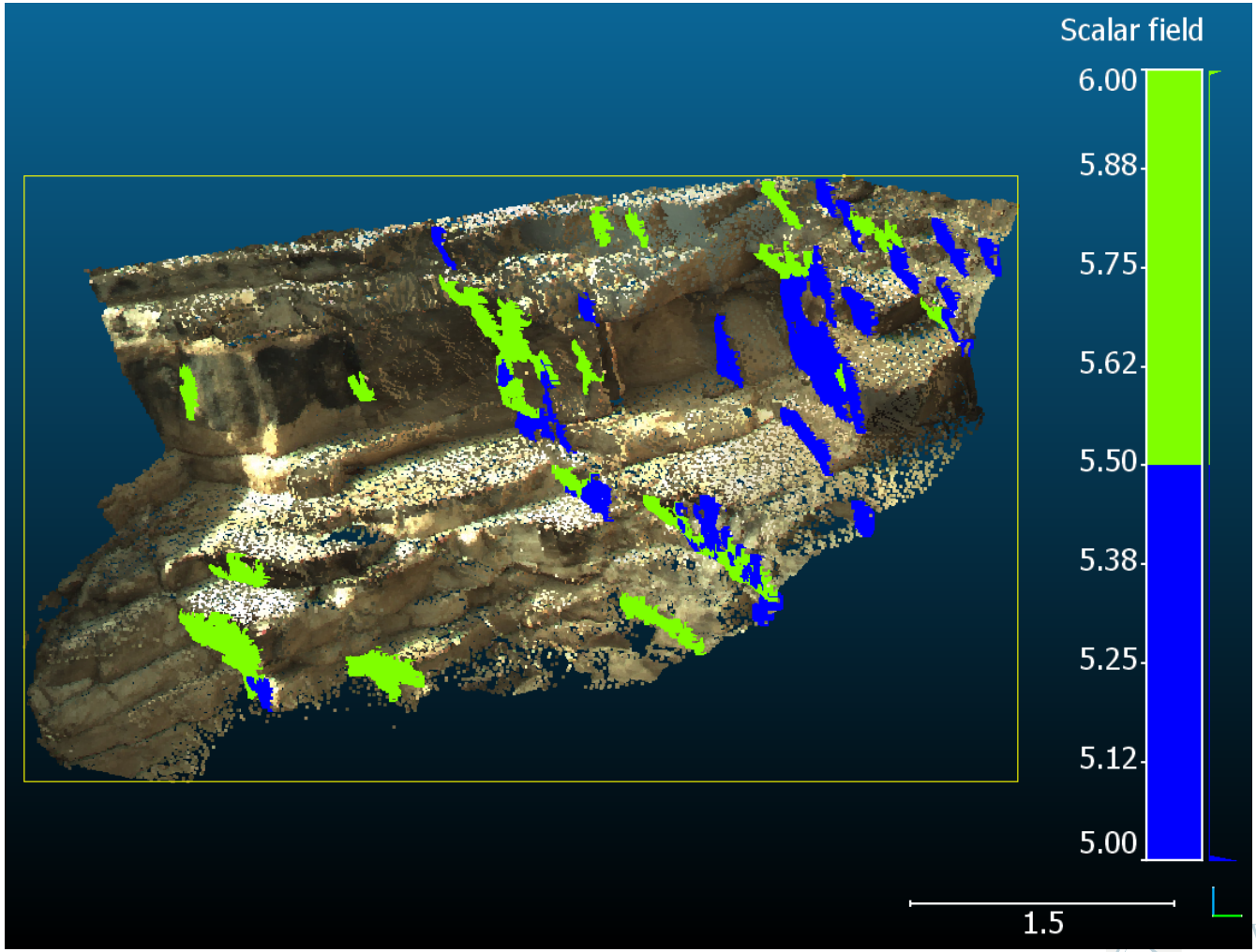

Figure. DS 5 and 6 usually are contiguous, so they are considered as a single DS.

Results

Table. Extracted discontinuity sets and main properties.

DS	Orientation	Normal spacing	Persistence (m)		
			Dip dir	Strike	Max
J_1	114/32	0.272	1.653	4.083	4.083
J_2	268/65	0.249	1.490	3.516	3.516
J_3	298/59	0.181	1.287	2.783	2.783
J_4	242/68	0.380	3.234	2.498	3.234
J_5	343/72	0.315	0.995	1.733	1.733

$$J_v = \sum_{i=1}^{5} \frac{1}{Jv_i} = 19.02 \left(\frac{joints}{m^3} \right) \quad (1)$$

$$RQD = 110 - 2.5 \cdot 19.02 = 62.44 \quad (2)$$

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Rock Mass Rating and Slope Mass Rating index

Table 1. Calculation of the RMR_b for each discontinuity set. X_1 to X_5 are the corresponding parameters (Bieniawski, 1993).

Disc. Set	Separation [mm]	Rough.	Infilling	Weath.	RMR_b parameters									RMR_b
					X_1	X_2	X_3	X_{41}	X_{42}	X_{43}	X_{44}	X_{45}	X_5	
J_1: 114/32	1 - 5	slightly	hard <5	Unw.	12	20	10	0	1	3	4	6	15	71
J_2: 268/65	1 - 5	slightly	hard <5	Unw.	12	20	10	2	1	3	4	6	15	73
J_3: 298/59	1 - 5	slightly	hard <5	Unw.	12	20	8	4	1	3	4	6	15	73
J_4: 242/68	1 - 5	slightly	hard <5	Unw.	12	20	10	2	1	3	4	6	15	73
J_5: 343/72	1 - 5	slightly	hard <5	Unw.	12	20	10	0	1	3	4	6	15	71

Table 2. SMRTool report. Slope:(111/77).

plane/wedge id	dip dir [°]	dip [°]	RMRb	A [°]	B [°]	C [°]	failure	F_1	F_2	F_3	F_4	SMR	Class
J_1	**114**	**32**	**71**	**3**	**32**	**-45**	**Planar**	**1**	**0.7**	**-60**	**15**	**44**	**III**
J_2	268	65	73	23	65	142	Toppling	0.4	1	-25	15	78	II
J_3	298	59	73	7	59	136	Toppling	0.85	1	-25	15	66	II
J_4	242	68	73	49	68	145	Toppling	0.15	1	-25	15	84	I
J_5	343	72	71	52	72	149	Toppling	0.15	1	-25	15	82	I
W_{12}	184	12	71	72.78	12.19	-64.81	Wedge	0.15	0.15	-60	15	84	I
W_{13}	27	2	71	84.09	1.82	-75.18	Wedge	0.15	0.15	-60	15	84	I
W_{14}	162	23	71	50.77	22.78	-54.22	Wedge	0.15	0.4	-60	15	82	I
W_{15}	65	22	71	45.7	22.41	-54.59	Wedge	0.15	0.4	-60	15	82	I

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Conclusions

- The RMR_b and SMR indexes were calculated using data extracted from 3DPC, using open source software.
- The geometrical analysis of the planes can be reproduced by any user if the analysis parameters are provided.
- Use of qualitative data acquired during the fieldwork was required.

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