Structuurvorming monitoren

2 Oktober 2024, Martine van der Ploeg

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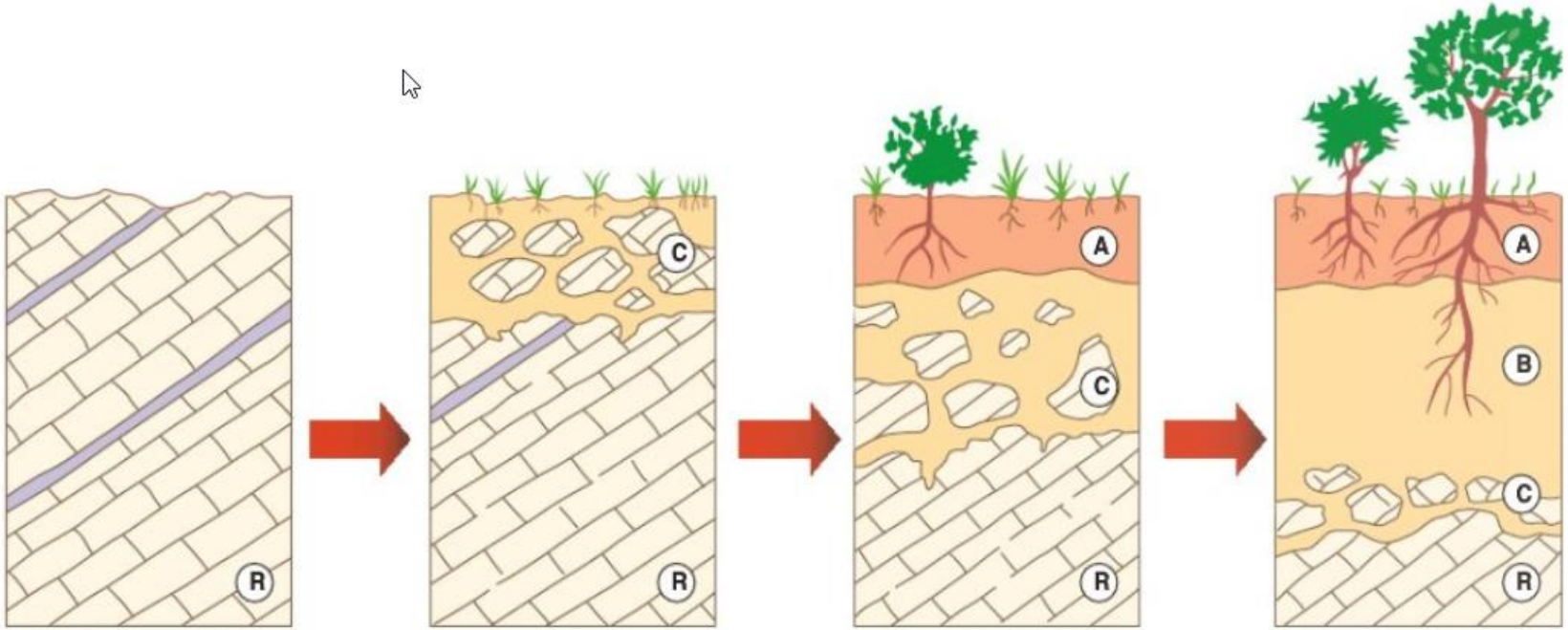
Bodemvormende processen



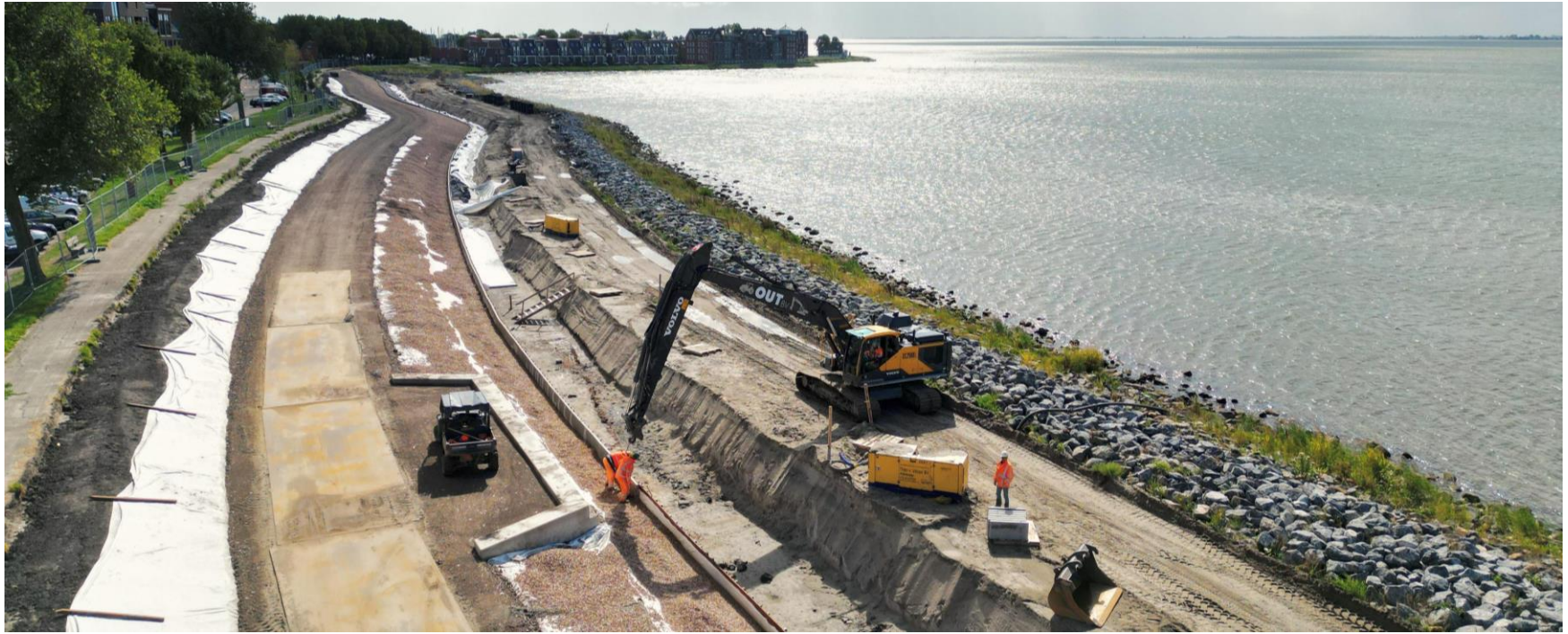
Primair gesteente

Verweringsdek/ pioniersvegetatie

Vorming humuslaag

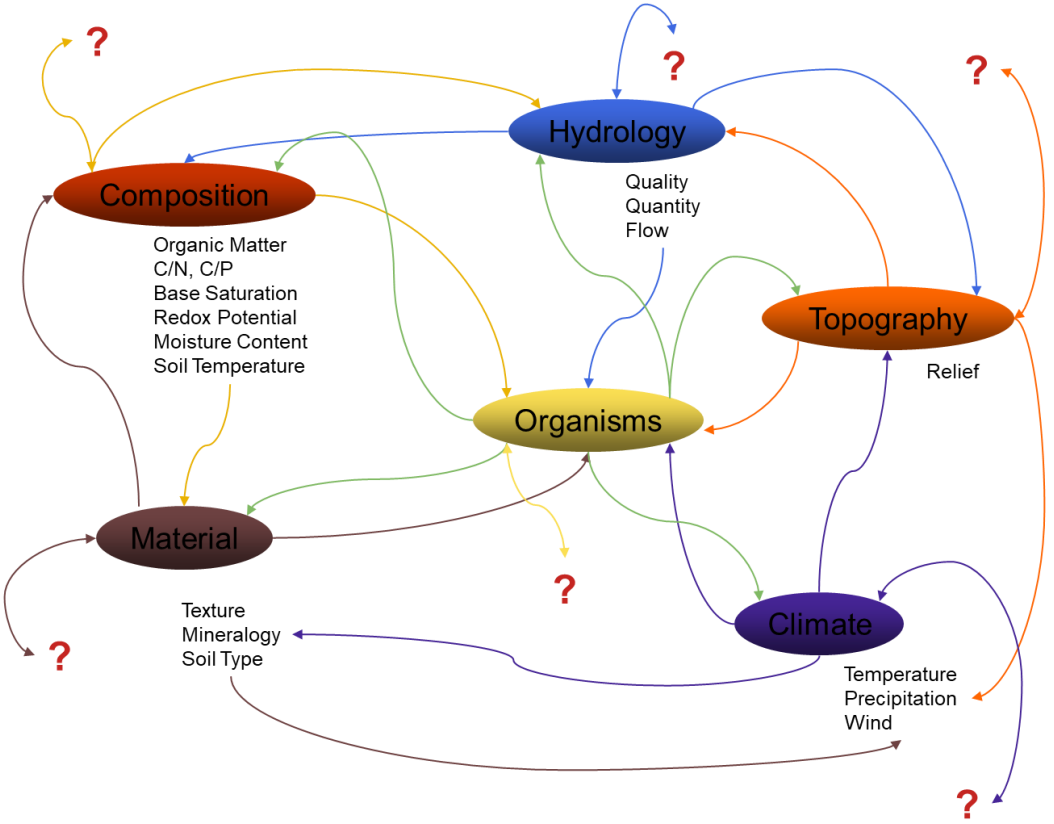
Vorming verschillende bodemlagen

Bodem en structuurvorming bij dijken?



Nieuwe dijk naast de Westerdijk-NH Dagblad

Natuurlijke bodem en structuurvormende processen



Extremen structuurvorming: scheuren

Waterkering
Van Ommerpolder
in 2018

Niek Bosma
Wetterskip Fryslan

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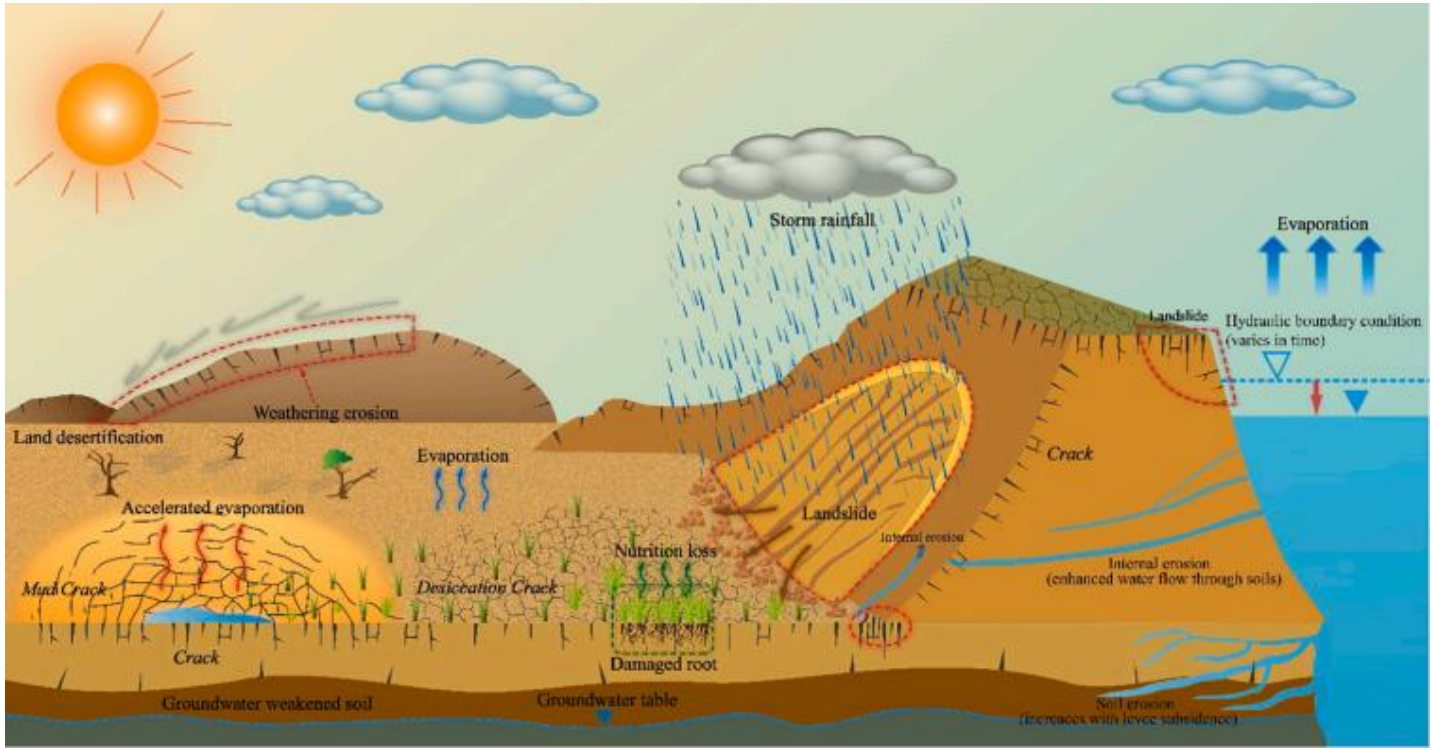
Extremen structuurvorming: verdichting

Dektares wiki noodmaatregelen

Mogelijke gevolgen van droogte/verdichting



Tang et al. 2021

Monitoren van structuurvorming

- Aantal voorbeelden vanuit het veld (niet persé dijken), in het lab kan ook van alles maar is vaak anekdotisch en op kleine schaal.
- Voorbeelden dienen ook voor rondvraag naar monitoring structuurvorming
- Discussie later vanmiddag

Monitoring

- Profielkuilonderzoek

- Penetrometer: Meten van compactie en draagkracht bodem

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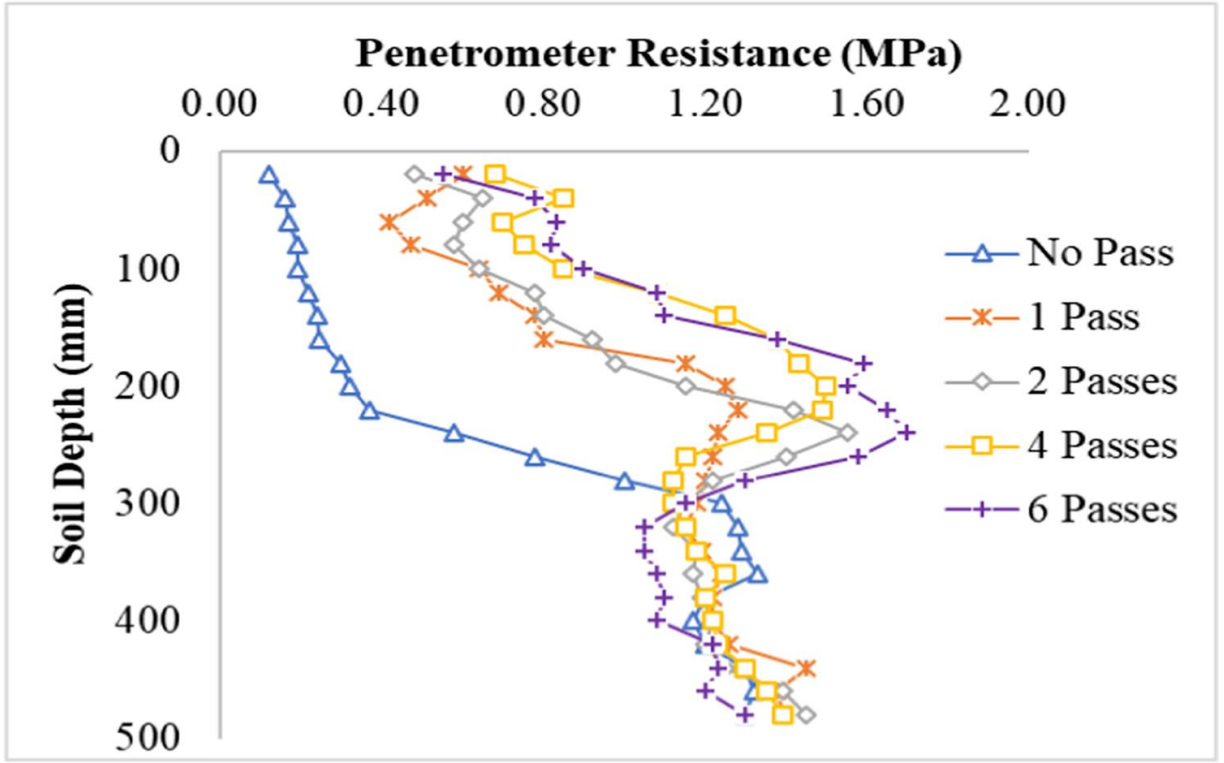
- Compactie door een combine harvester soil van 14.5 Mg/metric ton gemeten met een penetrometer van een geploegd bodem met silt/leem in Wisconsin.



- Shaheb, M.R., Venkatesh, R. & Shearer, S.A. A Review on the Effect of Soil Compaction and its Management for Sustainable Crop Production. J. Biosyst. Eng. 46, 417–439 (2021). https://doi.org/10.1007/s42853-021-00117-7

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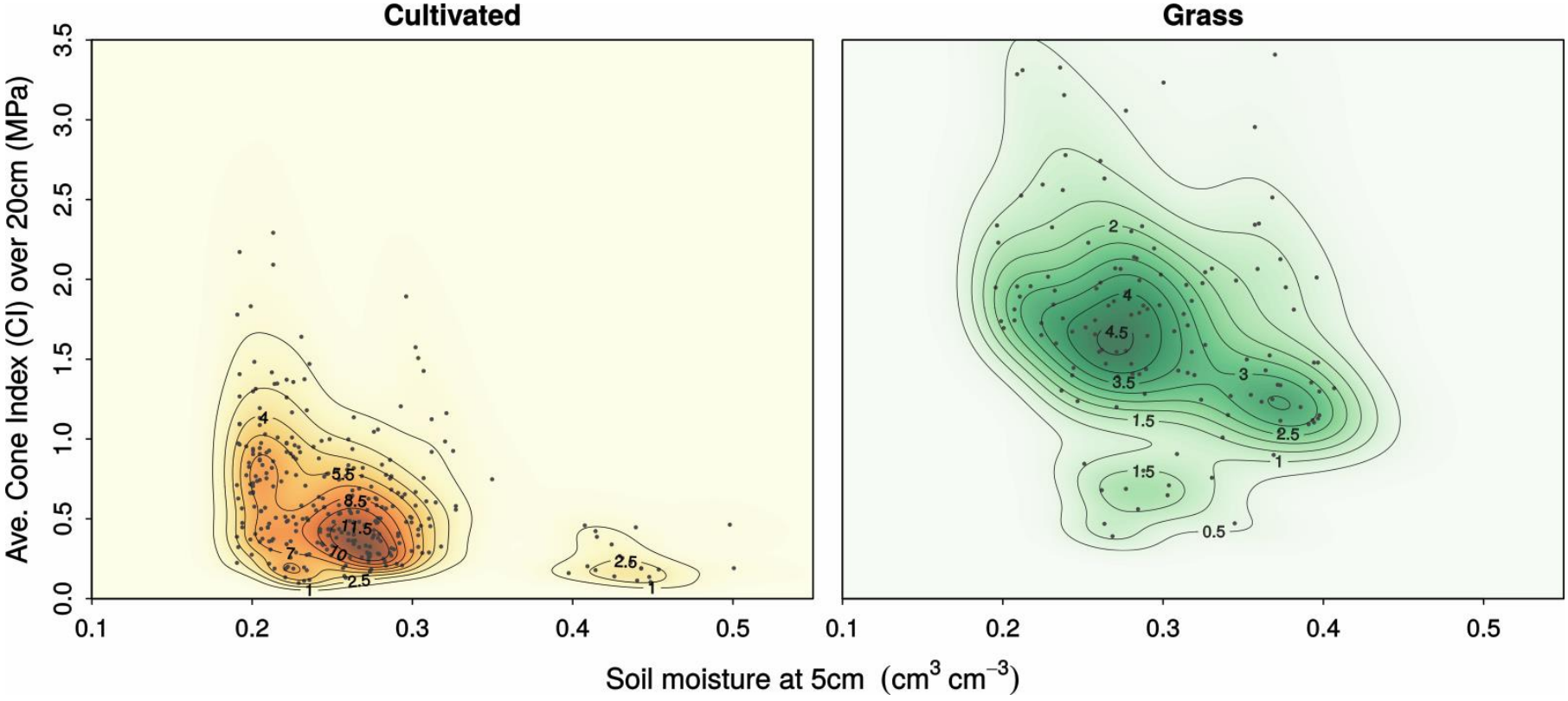
Invloed van bodemvocht op penetrometer weerstand

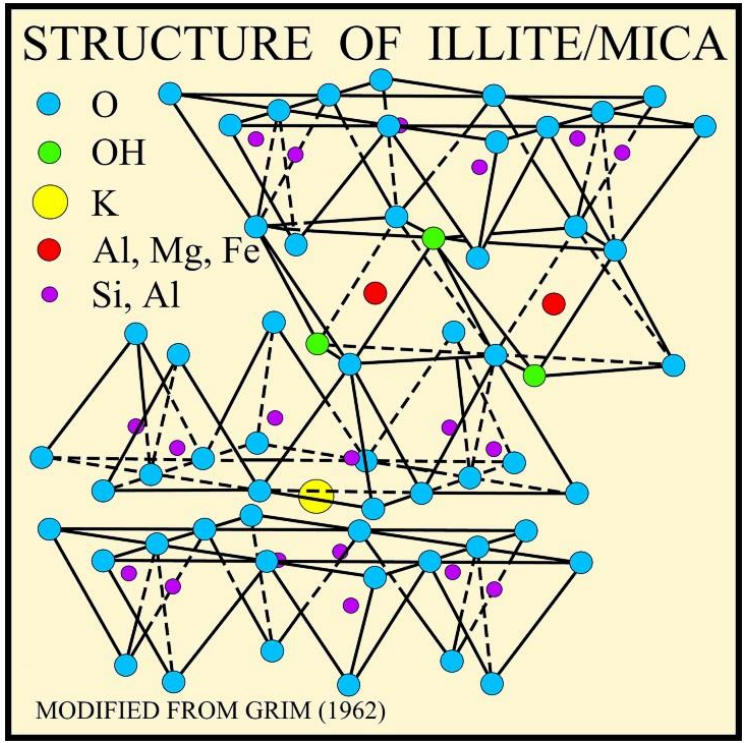


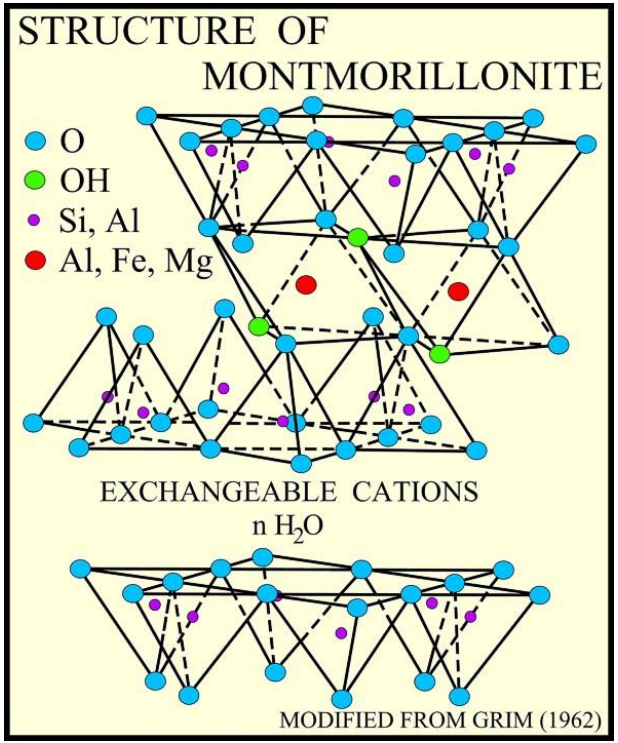
Kleimineralogie

- Massa % kleimineralen in de lutumfractie (<2 µm; zonder humus en $CaCO_3$)

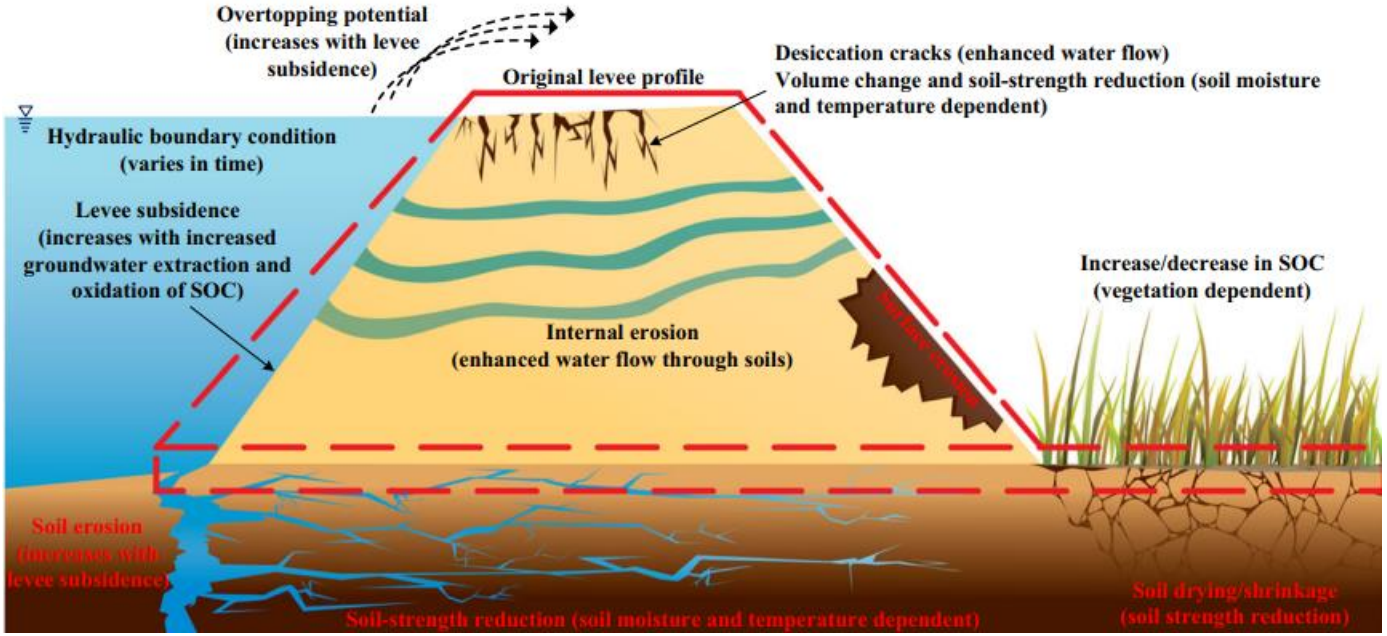
	kaoliniet	illiet	vermiculiet	smectiet	chloriet
Rivierklei Rijn	5 - 10	35 - 40	10 - 20	10 - 15	5 – 10
Zeeklei zoet Zuid Holland	5 - 10	35 - 40	10 - 20	10 - 15	5 – 10
Zeeklei Friesland/Groningen	5 - 10	30 - 40	< 5	30 - 40	< 5

- Vermiculiet en smectiet zijn zwellende/krimpende kleimineralen
    - In Friesland/Groningen is ~35% van de klei zwellend/krimpend


STRUCTURE OF ILLITE/MICA
O
OH
K
Al, Mg, Fe
Si, Al
MODIFIED FROM GRIM (1962)


STRUCTURE OF
MONTMORILLONITE
O
OH
Si, Al
Al, Fe, Mg
EXCHANGEABLE CATIONS
n H2O
MODIFIED FROM GRIM (1962)

Gevolgen krimp door droogte



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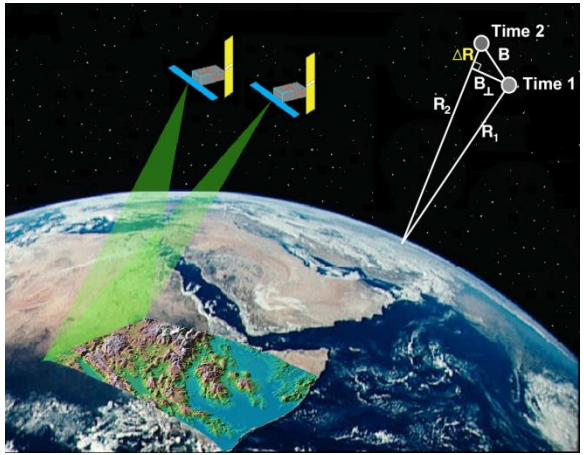
Monitoren zwel-krimp



1st acquisition

phase 1

2nd acquisition

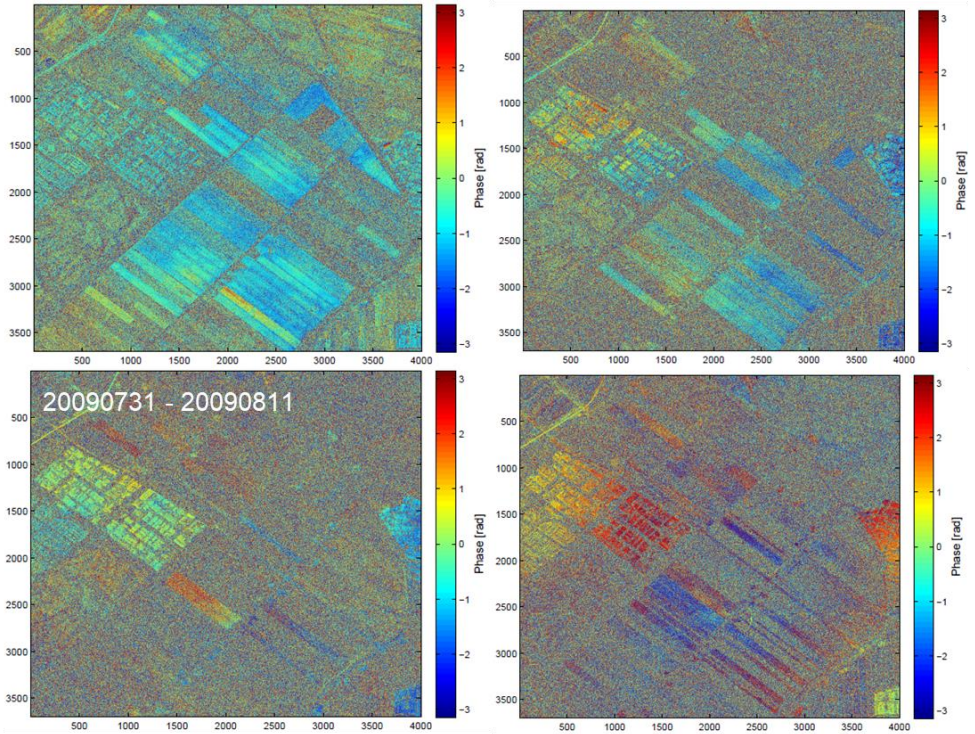
phase 2

Phase change: fraction of wavelength [-π, π]

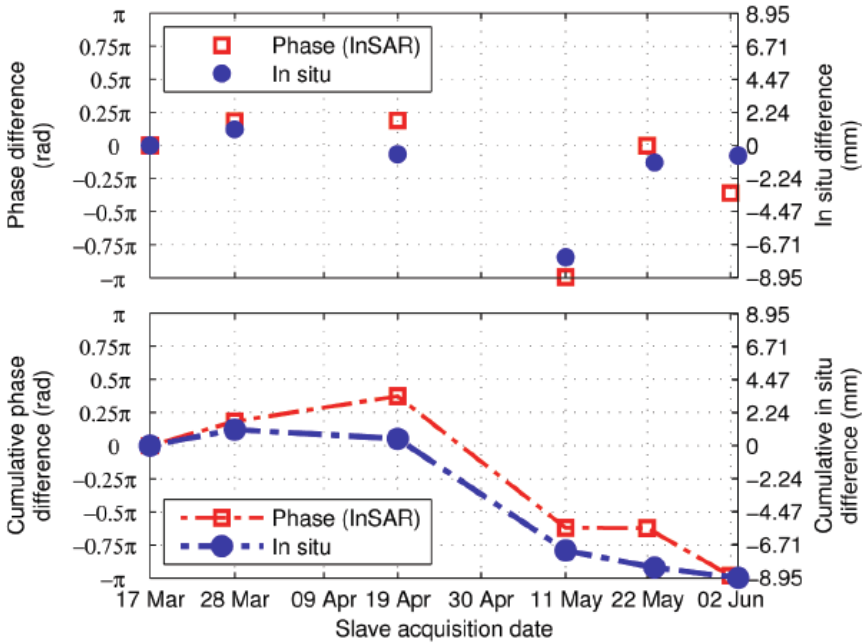
SRON project: regionale waterbalans

TerraSAR-X data

Orbit	Ascending
Wavelength	3.1 cm (9.65 GHz)
Spatial resolution	3 m
Repeat cycle	11 days

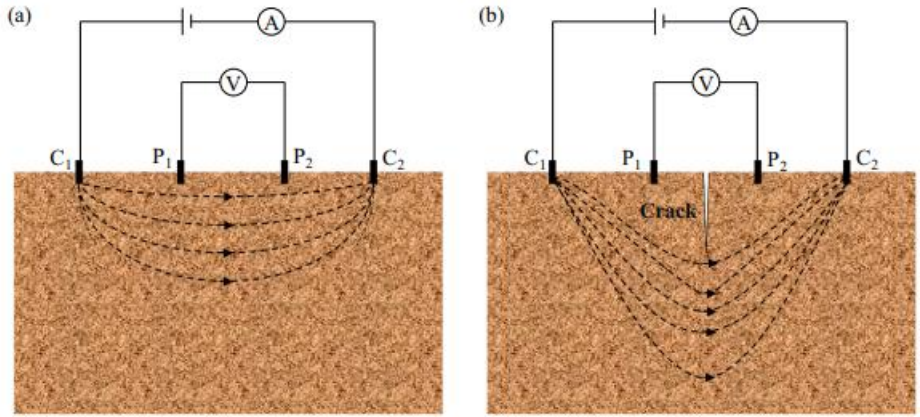


1 colour cycle equivalent to 16 mm line of sight displacement

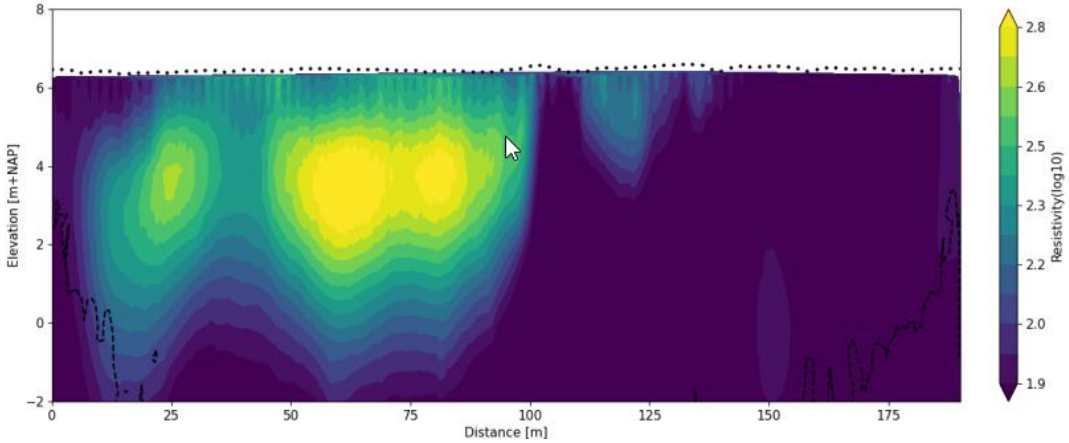


Te Brake et al. 2013 HESS; VZJ

Electrical resistivity tomography



Grote schaal



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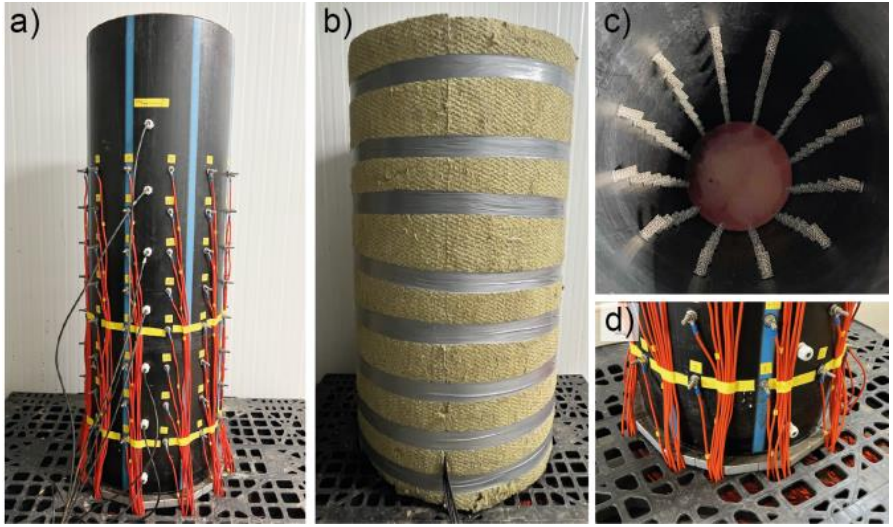
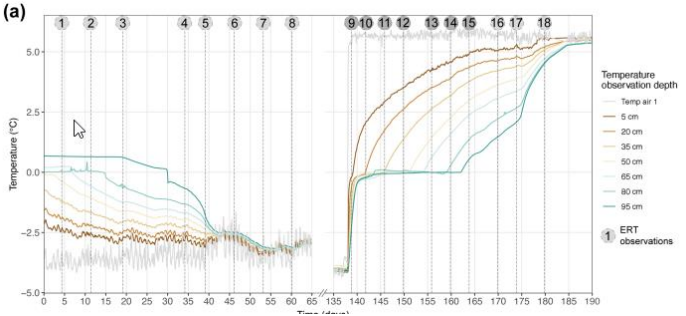
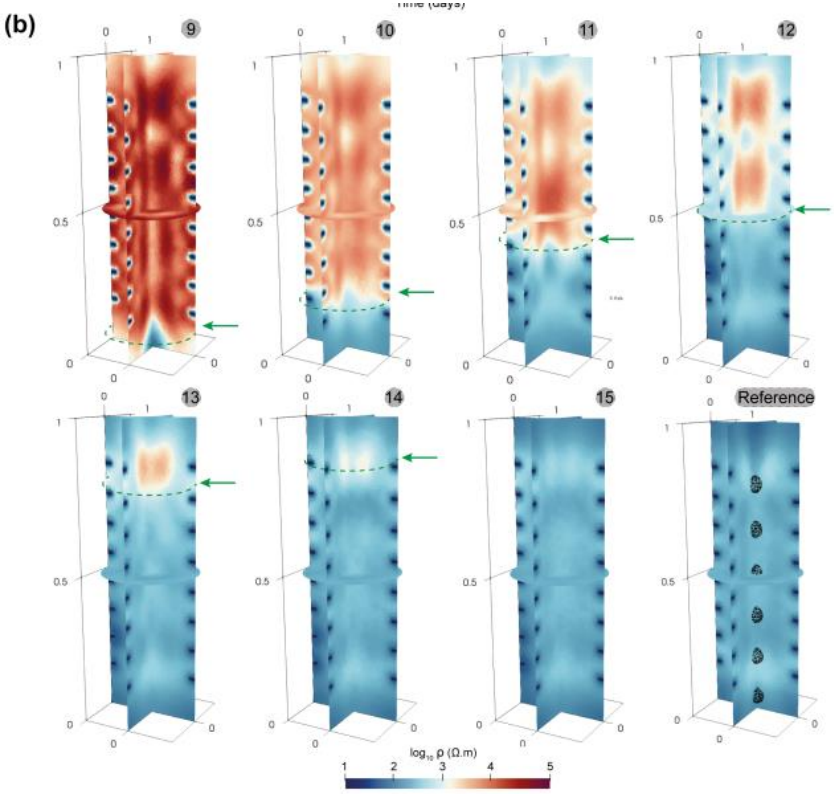
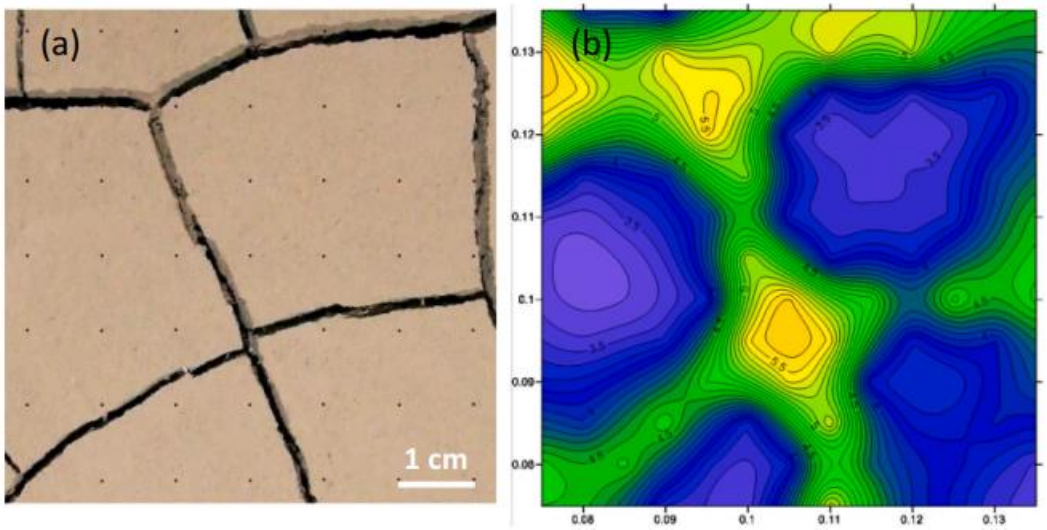
Kleine schaal








(a)
1 cm
(b)
0.13
0.12
0.11
0.1
0.09
0.08
0.08
0.09
0.1
0.11
0.12
0.13

Uit publicaties

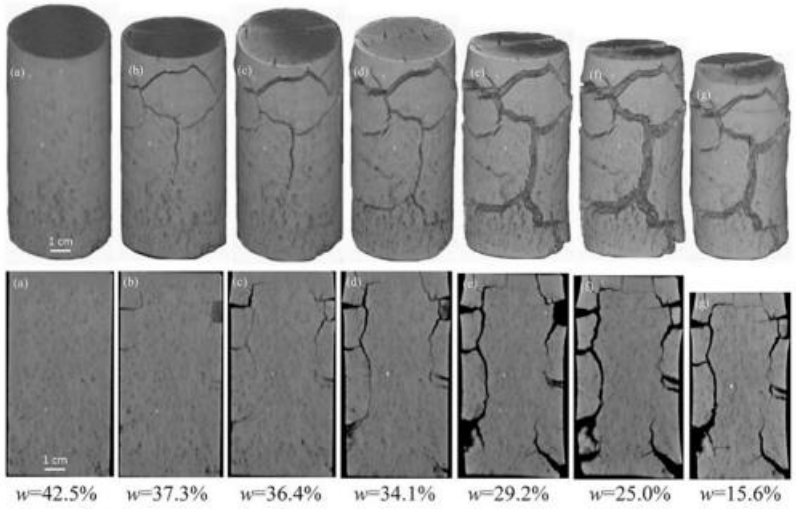


Table 2
State of the Art: experimental methods developed to quantify desiccation crack morphology of soils.

Characterization method	Specimen dimension	Characterization parameter	References
	• (L*W*D) (lab/field) • diameter*thickness (lab) • L*W (field)		
Camera (lab and field)	1.5 m * 1.0 m * 0.5 m (field)	Crack intensity factor	(Miller et al., 1998)
	400 mm * 7 mm * 5 mm (lab)	Number of cracks, crack width, separation between cracks	(Lecocq and Vandewalle, 2002)
	24 cm * 30 cm * 5 mm (lab)	Minkowski numbers, Minkowski functions, angles of bifurcation	(Vogel et al., 2005b)
	160 mm *160 mm * 5 mm (lab)	Number of crack segments and intersections, total/average crack length, average crack width, number of clods, average area of clods, surface crack ratio, probability density functions (PDF), fractal dimension	(Tang et al., 2007b)
	2.44 m * 2.44 m * 1.22 m (field)	Crack area, fractal dimension, crack area mass fractal dimension	(Baer et al., 2009)
	1189–297 mm * 841–210 mm * 10–20 mm (field)	Surface shrinkage, total crack area, average area of cells, total crack length, average crack width, length of crack per unit area	(Lakshmikantha et al., 2009)
	295 mm * 49 mm * 12 mm (lab)	Number of cracks, crack-spacing, crack opening, intercepting angle	(Péron et al., 2009b)
	295 mm * 15 mm * 15 mm (lab)		
	16 cm * 16 cm * 8 mm (lab)	Surface crack ratio, crack intersection angle, number of intersection, number of crack segment, average length of crack, average width of crack, average area of aggregates, crack intensity factor, probability distribution of crack length	(Tang et al., 2008, 2011a, 2011b; Liu et al., 2013)
	117 mm * 2.5–5 mm (lab)		
	100 mm * 5 mm (lab)	Crack intensity factor, density of length of fissure	(Trabelsi et al., 2012)
	80 mm * 80 mm * 3–20 mm (lab)	Tensile strain	(Costa et al., 2013)
	180 mm * 210 mm (field)	Crack porosity, crack aperture, crack density, density of crack polygon, spatial distribution of crack, crack orientation	(Li and Zhang, 2010, 2011)
	525 mm * 820 mm (field)		
	430 mm * 430 mm * 25 mm (lab)	Crack velocity, crack angle, crack width distribution, crack length and density, fractal dimension of the crack network, correlation function of crack area	(DeCarlo and Shokri, 2014a)
	9.689 cm * 1.292 cm (lab)	Area of gap, area of crack, area of settlement	(Sánchez et al., 2013)
Laser device (lab)	7.2 cm * 10.8 cm (lab)	Crack aperture, crack porosity, specific surface area	(Gebrenegus et al., 2011)
	9.689 cm * 1.292 cm (lab)	Surface elevation, crack depth, crack area, soil volume	(Sánchez et al., 2013)
	80 mm * 40 mm (lab)	crack specific parameters (depth, length, width, and volume)	(Uday and Singh, 2013a)
X-ray Computed Tomography (lab)	40.5 mm * 40.5 mm * 56 mm (lab)	Crack fraction, dead and branch number, crack depth, maximum crack velocity, specific volume	(DeCarlo and Shokri, 2014b)
	12 cm * 12 cm (lab)	crack aperture distributions, crack porosities, and crack specific surface areas	(Gebrenegus et al., 2011)
	7.54 cm * 2 cm (lab)	crack area, crack width, crack depth and crack intersection angles	(Julina and Thyagaraj, 2019)
	50 mm * 100 mm (lab)	Soil mass area, shrinkage ratio, crack ratio, average crack width, total crack length, number of crack segment	(Tang et al., 2019)
Ground penetration radar (field)	1300 mm * 650 mm (field)	Electrical anisotropy	(Greve et al., 2010)
Electrical resistivity tomography (lab and field)	180 mm *180 mm * 30 mm (lab)	Apparent electrical resistivity	(An et al., 2020)
	29 cm * 3 cm * 2 cm (lab)	Apparent electrical resistivity	(Tang et al., 2018)
	2.4 dm * 1.7 dm * 1.6 dm (lab)	Apparent electrical resistivity	(Samouelian et al., 2003)
	100 m * 6 m (field)	2D and 3D apparent electrical resistivity field	(Jones et al., 2014)
	49.5 cm * 49.5 cm * 17.5 cm (lab)	3D apparent electrical resistivity	(Jones et al., 2012)
	Petri dish of 10 cm diameter (lab)	Electric field	(Tarafdar and Dutta, 2019)
Fiber-optical sensing (lab and field)	200 cm * 9 cm * 7 cm (lab)	Surface crack ratio	(Li and Zhang, 2010)
	250 mm * 25 mm * 18 mm (lab)	Strain, drying rate	(Costa et al., 2018)
Digital Image Correlation (lab)	117 mm * 117 mm * 8 mm (lab)	Strain field	(Wang et al., 2018b)
	5.5 cm * 4 cm (lab)	Volume strain, local strain	(Peth et al., 2010)
Particle image velocimetry (lab)	Restrained ring ($d_{out\text{-}ring}$ = 133 mm; $d_{inner\text{-}ring}$ = 40 mm)	Strain field	(Shannon et al., 2015)
Scanning Electron Microscopy (lab)	20 mm * 20 mm * 20 mm	Crack network	(Fauchille et al., 2014)
	12 cm* 0.5 cm	Local particle alignment	(Mal et al., 2008)
	4 mm * 4 mm * 2 mm	Water sensitivity, crack type, clay mineral proportion, dominant clay family	(Montes et al., 2004)
	150 mm * 3 mm	Micro crack, salt precipitation pattern	(Shokri et al., 2015)
	600 μm * 600 μm * 2/5/10 nm	crack spacing, crack density, crack length	(Seghir and Arscott, 2015)
	300 μm * 300 μm * 2/5/10 nm		
	100 μm * 100 μm * 2/5/10 nm		
Field observation	Tens of meters wide and up to 300 m wide polygons	Large desiccation polygons in playas in California, USA	(Neal et al., 1968)
	Kilometer-scale	Giant cracks on Mars	(McGill and Hills, 1992; Pechmann, 1980)
	1–30 m wide	Image obtained from the imaging spectrometer orbiting Mars	(El-Maarry et al., 2015a, 2015b, 2015c)
	A series of distinctive centimeter-scale reticulate ridges on Mars	Maximum width; vertex angles	(Stein et al., 2018)

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