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A simple toolbox for evaluating the combined contributions to the whole-rock magnetic fabric

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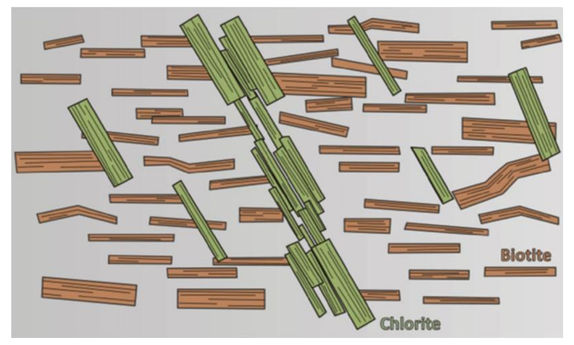
Motivation

- The interpretation of magnetic fabric (studied mainly by means of anisotropy of magnetic susceptibility, AMS) has become one of the well-established, fast, and reliable rock fabric proxies used in many branches of the Earth science.
- In the usual case, the magnetic fabric ellipsoid reflects the crystallographic or shape preferred orientation of the grains of the main rock-constituent mineral.
- If two (or more) sets of mineral grains are present, their combined contribution towards the whole-rock magnetic fabric is proportional to their relative content, their value of bulk susceptibility and their degree of anisotropy.



Methods

In order to overcome some misconception on how various magnetic fabrics can contribute to the overall rock fabric, we present a simple toolbox for visualizing a combined contribution of two pre-defined end-member magnetic sub-fabrics.

These end-member fabrics (**A** and **B**) are defined by their:

- Bulk susceptibility (Km) — $Km = (k_1 + k_2 + k_3) / 3$
- Degree of anisotropy (P) — $P = k_1 / k_3$
- Shape of anisotropy ellipsoid (T) — $T = 2 \ln(k_2 / k_3) / \ln(k_1 / k_3) - 1$
- Orientations of the principal directions — K_{max} and K_{min}

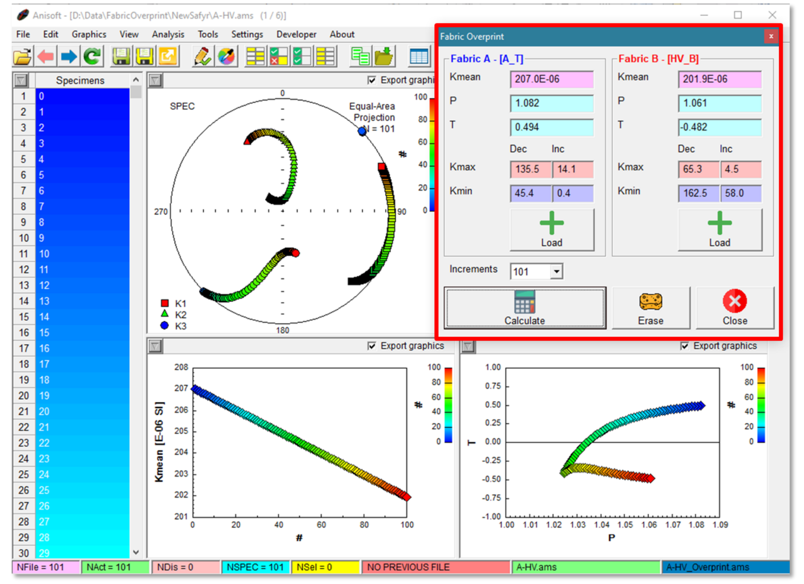
The combined fabric (**C**) is calculated in multiple increments using the following simple equation:

$$\mathbf{K}_C = c_A \cdot Km_A \cdot \mathbf{Kn}_A + c_B \cdot Km_B \cdot \mathbf{Kn}_B$$

where

c – volume contribution ($c_B = 1 - c_A$)
Km – mean susceptibility
Kn – normalized anisotropy tensor

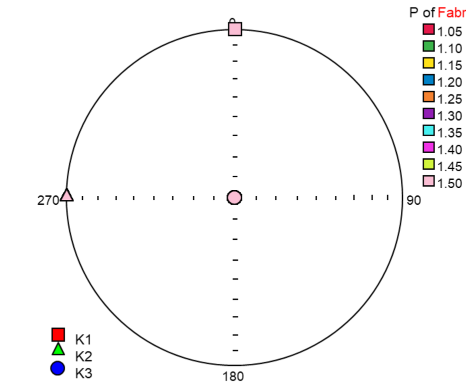
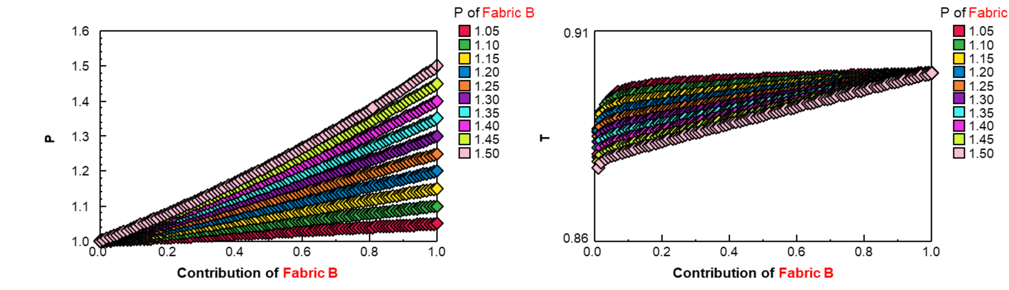
User interface



The toolbox is part of Anisoft software which enables the instant visualization of magnetic fabric changes as a function of the relative content of the end-member sub-fabrics. Available at www.agico.com

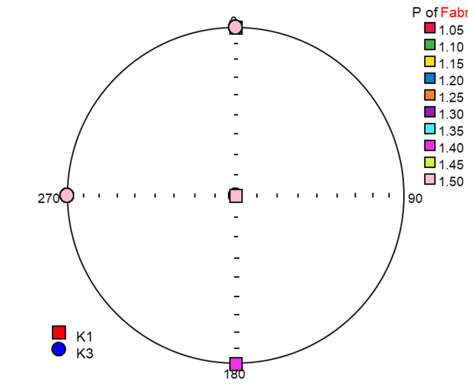
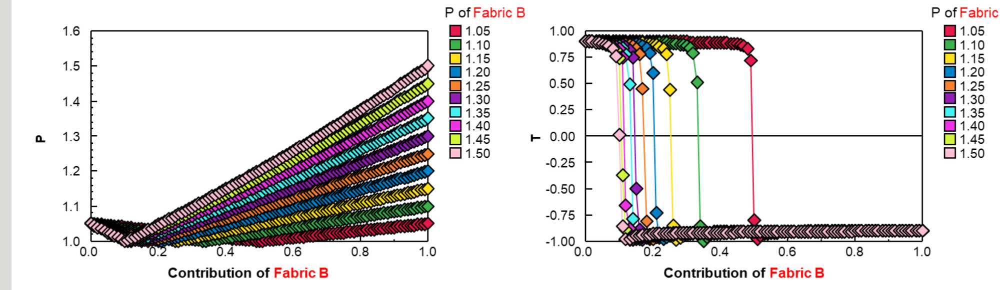
Model 1: Anisotropic vs. Isotropic fabric

	Fabric A		Fabric B	
Fabric	Isotropic		Anisotropic Oblate Variable anisotropy	
K_{mean}	1		1	
P	1.001		1.05 to 1.50	
T	0.0		0.9	
K_{max}	0	0	0	0
K_{min}	90	90	90	90

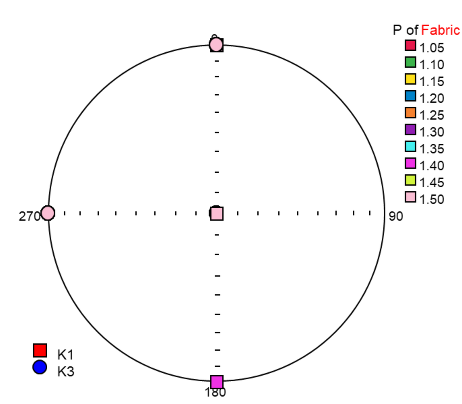
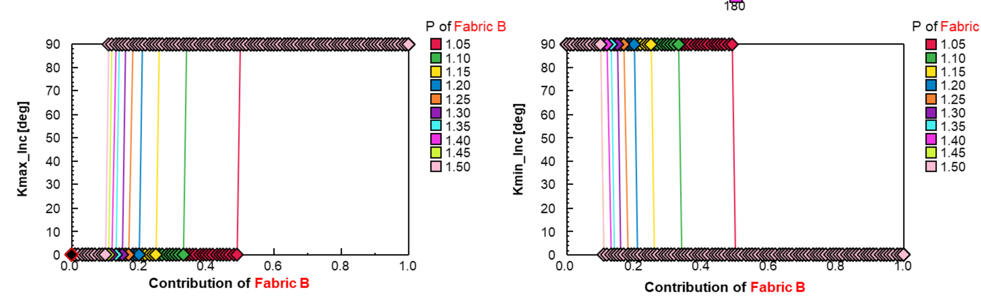
Model 2: Normal vs. Inverse fabric

	Fabric A		Fabric B	
Fabric	Normal Oblate		Inverse Prolate Variable anisotropy	
K_{mean}	1		1	
P	1.05		1.05 to 1.50	
T	0.9		-0.9	
K_{max}	0	0	90	90
K_{min}	90	90	0	0

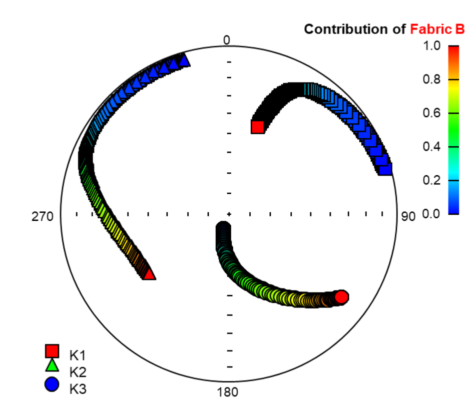
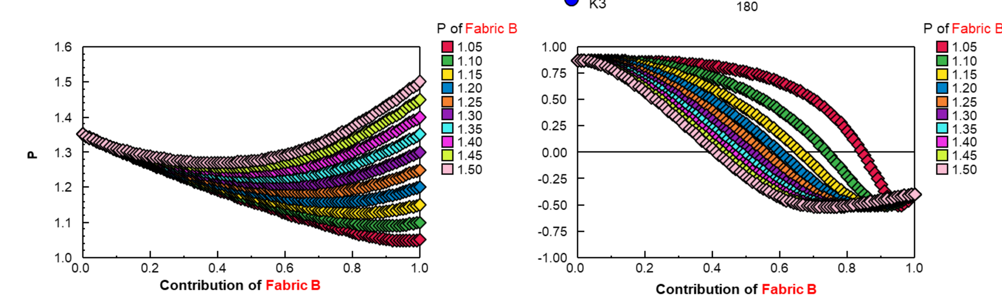
Model 2: Normal vs. Inverse fabric

	Fabric A		Fabric B	
Fabric	Normal Oblate		Inverse Prolate Variable anisotropy	
K_{mean}	1		1	
P	1.05		1.05 to 1.50	
T	0.9		-0.9	
K_{max}	0	0	90	90
K_{min}	90	90	0	0

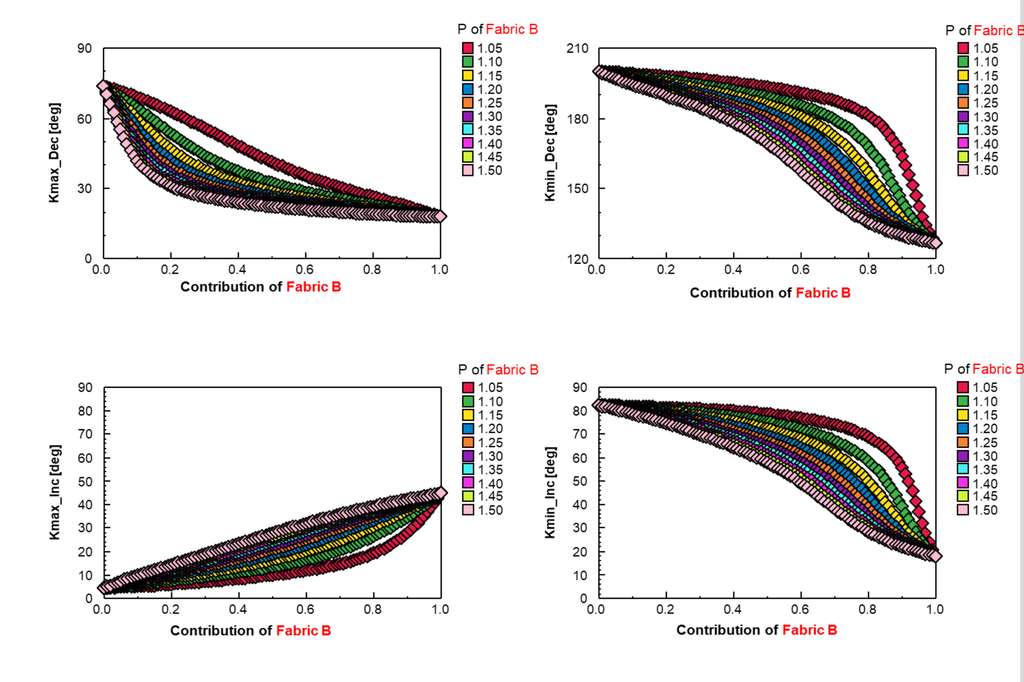



Model 3: Para vs. Ferro fabric

	Fabric A		Fabric B	
Fabric	Paramagnetic		Ferromagnetic Variable anisotropy	
K_{mean}	1		1	
P	1.35		1.05 to 1.50	
T	0.867		-0.396	
K_{max}	73.9	4.5	17.8	44.8
K_{min}	200.0	82.4	126.7	18.0

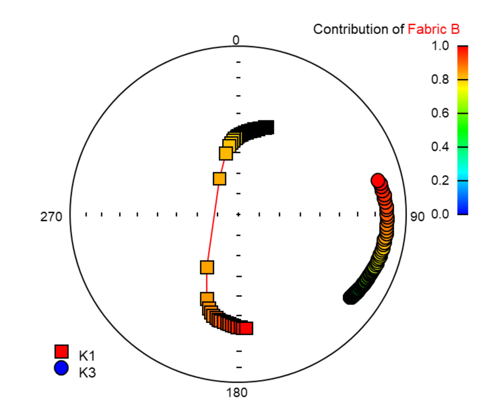
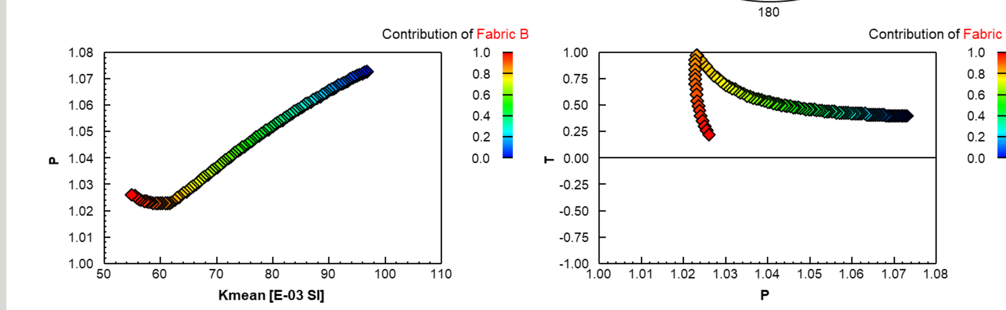



Model 3: Para vs. Ferro fabric



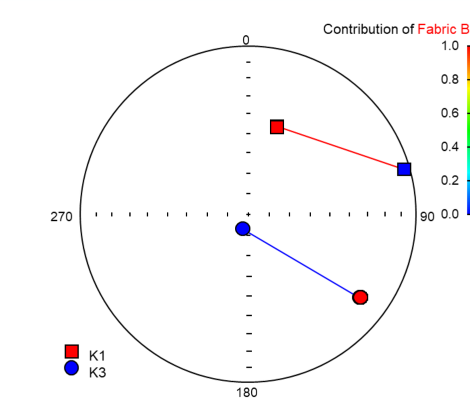
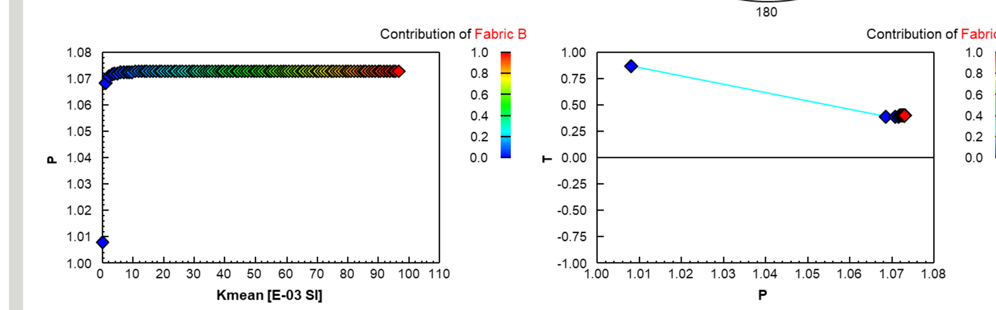
Example 1: Comparable K_m and P

	Fabric A		Fabric B	
Rock	Welded volcanic ash		Basalt	
K_{mean}	96.69E-03		54.96E-03	
P	1.073		1.026	
T	0.396		0.220	
K_{max}	17.8	44.8	176.5	32.7
K_{min}	126.7	18.0	76.3	15.4

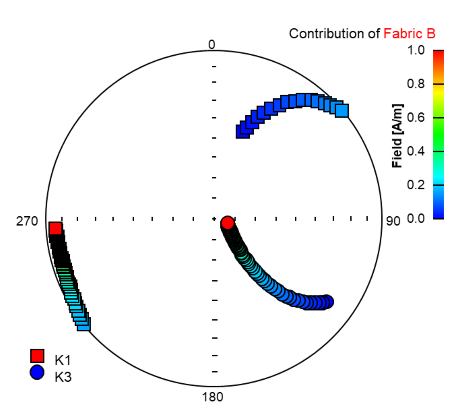
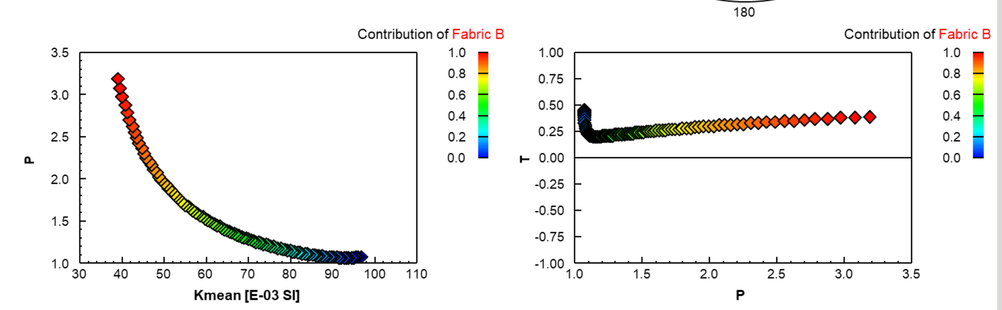
Example 2: High K_m dominates

	Fabric A		Fabric B	
Rock	Limestone		Welded volcanic ash	
K_{mean}	60.89E-06		96.69E-03	
P	1.008		1.073	
T	0.867		0.396	
K_{max}	73.9	4.5	17.8	44.8
K_{min}	200.0	82.4	126.7	18.0

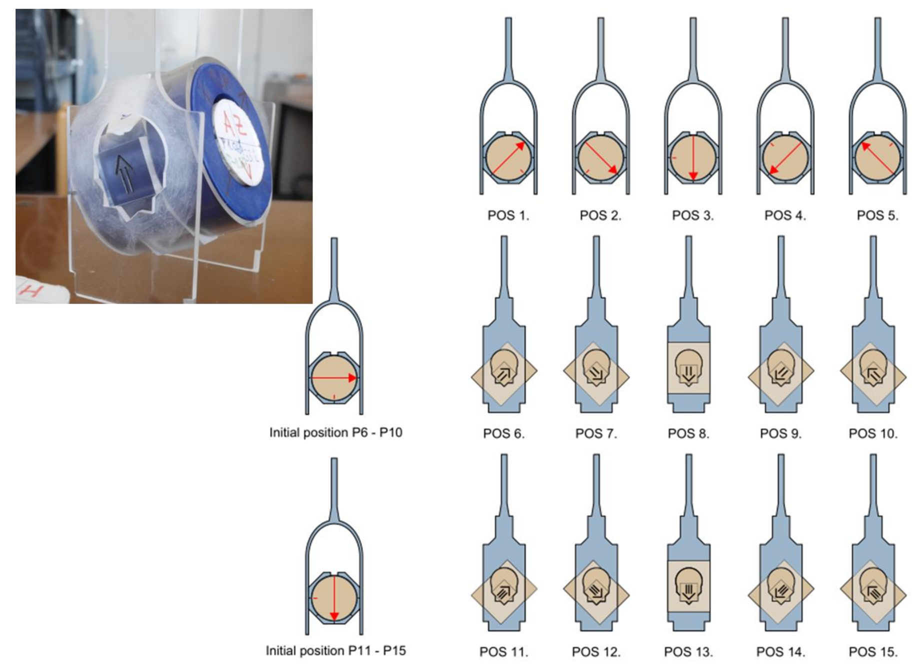
Example 3: High P dominates

	Fabric A		Fabric B	
Rock	Welded volcanic ash		Extremely anisotropic gneiss	
K_{mean}	96.69E-03		38.92E-03	
P	1.073		3.191	
T	0.396		0.391	
K_{max}	17.8	44.8	266.5	6.3
K_{min}	126.7	18.0	109.4	83.2

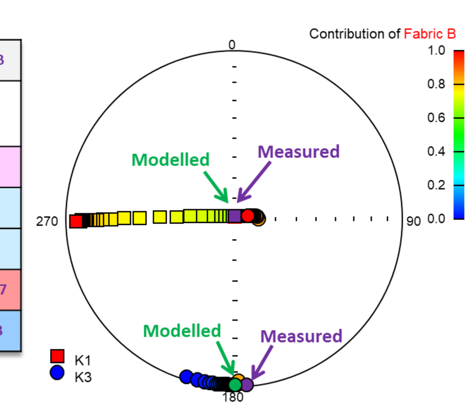
Experimental verification

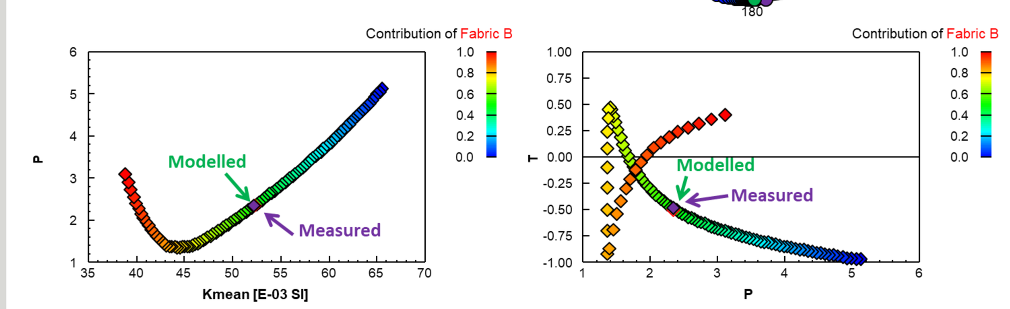
Experimental verification



Two high K_m and high P samples

	Fabric A		Fabric B		0.5 A + 0.5 B		0.5 A + 0.5 B	
Rock	Calibration standard		Extremely anisotropic gneiss		Modelled fabric		Measured	
K_{mean}	65.55E-03		38.87E-03		52.21E-03		52.24E-03	
P	5.129		3.110		2.339		2.340	
T	-0.974		0.398		-0.484		-0.501	
K_{max}	55.2	87.2	269.2	6.6	2.3	88.4	352.1	88.7
K_{min}	196.6	2.2	76.5	83.2	179.6	1.6	175.8	1.3





Two low K_m and low P samples

	Fabric A		Fabric B		0.5 A + 0.5 B		0.5 A + 0.5 B	
Rock	Shale		Siltstone		Modelled fabric		Measured	
K_{mean}	206.8E-06		201.4E-06		204.1E-06		202.6E-06	
P	1.081		1.060		1.026		1.026	
T	0.526		-0.568		-0.329		-0.227	
K_{max}	136.8	13.1	66.0	2.4	117.7	1.6	118.5	0.1
K_{min}	46.5	1.2	160.3	60.7	207.9	8.5	208.5	12.0