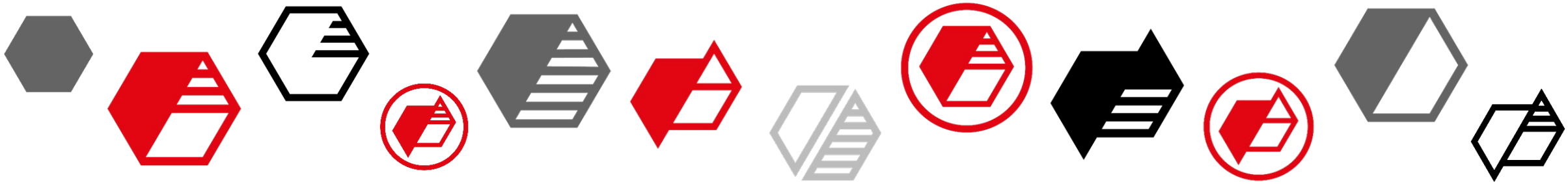

# Filler comparison

## Non black fillers in sulfur cured EPDM rubber – extrusion application

**Author:** Meier Julia

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# Contents


- Introduction
- Experimental
- Results
- Appendix
  - ¬ Results in tabular form
  - ¬ Images Garvey extrudates

# Status Quo

Aim of the investigation:

Representation of the performance of Neuburg Siliceous Earth grades compared to competitors in a sulfur-cured EPDM formulation for extrusion applications.

The components of the formulation have been adapted to the latest specifications regarding raw materials and the accelerator system.

A hardness of approx. 70 Shore A was targeted.

# Experimental

- Formulation
  - ¬ Formulation for the determination of the results after vulcanization and after aging
  - ¬ Formulation for extrusion
- Fillers
  - ¬ Neuburg Siliceous Earth (NSE)
  - ¬ Competitors
- Compounding and vulcanization
- Test standards - overview

# Formulation for the determination of the results after vulcanization and after aging

| Ingredients | Description | phr |
|---|---|---|
| Vistalon 7700 | Ethylene propylene diene rubber<br>ML 1+8 (125 °C): 115 MU | 100 |
| Zinkoxyd activ | Zinc oxide active | 5 |
| Edenor C18 98-100 GW | Stearic acid | 2 |
| Fillers | *Please see slides „Fillers“* | variable<br>(300 / 180 / 150 / 90) |
| DEG | Diethylene glycol | variable (0 / 2 / 5) |
| Process Oil P 460 | Paraffinic mineral oil, plasticizer | 70 |
| Kezadol GR | Calcium oxide, desiccant | 10 |
| Rhenogran ZBEC-70 | Zinc dibenzyl dithiocarbamate, 70%, accelerator | 2 |
| Rhenogran CBS-80 | N-cyclohexylbenzothiazole-2-sulfenamide, 80 %, accelerator | 0.5 |
| Rhenogran TP-50 | Zinc dithiophosphate, 50%, accelerator | 2 |
| Rhenogran MBTS-80 | 2-Mercaptobenzthiazole, 80%, accelerator | 1.3 |
| Rhenogran S-80 | Sulfur, 80 %, crosslinking agent | 0.75 |
| Rhenogran CLD-80 | Caprolactam disulfide, 80 %, crosslinking agent | 1 |
| **Total:** | | **max. 499.55 / min. 284.55** |

# Formulation for extrusion

→ Extrusion was carried out without coactivator and crosslinking system.
In addition, 2 phr of the processing aid Aflux 42 were added

| Ingredients | Description | phr |
|---|---|---|
| Vistalon 7700 | Ethylene propylene diene rubber<br>ML 1+8 (125 °C): 115 MU | 100 |
| Zinkoxyd activ | Zinc oxide active | 5 |
| Edenor C18 98-100 GW | Stearic acid | 2 |
| Fillers | *Please see slides „Fillers“* | variable<br>300 / 180 / 150 / 90 |
| DEG | Diethylene glycol | variable<br>0 / 2 / 5 |
| Process Oil P 460 | Paraffinic mineral oil, plasticizer | 70 |
| Kezadol GR | Calcium oxide, desiccant | 10 |
| Aflux 42 | Processing aids | 2 |
| **Total:** | | **max. 494 / min. 279** |

# Fillers – Neuburg Siliceous Earth (NSE)

| | phr (Filler) | phr (DEG) |
|---|---|---|
| Sillitin V 85 | 300 | 0 |
| Sillitin V 88 | 300 | 0 |
| Sillitin N 82* | 300 | 0 |
| Sillitin N 85 | 300 | 0 |
| Sillitin Z 86 | 300 | 0 |
| Sillitin Z 89 | 300 | 0 |
| Sillikolloid P 87 | 300 | 0 |
| | | 2 |

***Sillitin N 82 will be replaced by Sillitin N 75**

| | Basic material | Calcination | Functionalization | phr (Filler) | phr (DEG) |
|---|---|---|---|---|---|
| Silfit Z 91 | Sillitin Z 86 | ✓ | - | 300 | 0 |
| Aktifit AM | Silfit Z 91 | ✓ | Amino | 300 | 0 |
| Aktisil AM | Sillitin Z 86 | - | Amino | 300 | 0 |
| Aktisil PF 216 | Sillitin Z 86 | - | Tetrasulfane | 300 | 0 |
| Aktisil VM 56 | Sillitin Z 86 | - | Vinyl | 300 | 0 |
| Aktisil VM 56/89 | Sillitin Z 89 | - | Vinyl | 300 | 0 |
| Aktisil Q | Sillitin V 90 *Internal product quality | - | Methacrylic | 300 | 0 |
| Aktisil PF 777 | Sillitin Z 86 | - | Alkyl | 300 | 0 |

# Fillers – Competitors

| | Calcination | Functionalization | phr (Filler) | phr (DEG) |
|---|---|---|---|---|
| Carbon black N 550 | - | - | 150 | 0 |
| Precipitated silica 180 m²/g | - | - | 90 | 0 |
| | | | | 5 |
| Precipitated aluminum silicate | - | - | 150 | 0 |
| | | | | 2 |
| Precipitated calcium silicate | - | - | 180 | 0 |
| | | | | 2 |
| French Hard Clay | - | - | 300 | 0 |
| | | | | 2 |
| | | | | 5 |
| English Hard Clay | - | - | 300 | 0 |
| | | | | 2 |
| | | | | 5 |
| English Clay | - | - | 300 | 0 |
| | | | | 2 |
| English Soft Clay | - | - | 300 | 0 |
| | | | | 2 |

*only tested for mechanical properties

*tested only for extrusion

# Fillers – Competitors

| | Calcination | Functionalization | phr (Filler) | phr (DEG) |
|---|---|---|---|---|
| English calcined Clay | ✓ | - | 300 | 0 |
| American calcined Clay | ✓ | - | 300 | 0 |
| American calcined Clay, amino functionalized | ✓ | Amino | 300 | 0 |
| American calcined Clay, vinyl functionalized | ✓ | Vinyl | 300 | 0 |
| Whiting | - | - | 300 | 0 |
| Whiting, stearate functionalized | - | Stearic acid | 300 | 0 |
| American Talc | - | - | 300 | 0 |
| American coated Talc, amino functionalized | - | Amino | 300 | 0 |

# Compounding and vulcanization

| Compounding | |
|---|---|
| Open mill | Ø 150 x 300 mm |
| Batch weight | approx. 1000 g |
| Mill temperature | 50 °C |
| Mixing time | approx. 15 - 20 min. |

| Vulcanization | |
|---|---|
| The curing was carried out in a press at 180 °C | |
| Time | 5 min. or $t_{90}$ + 10 % |

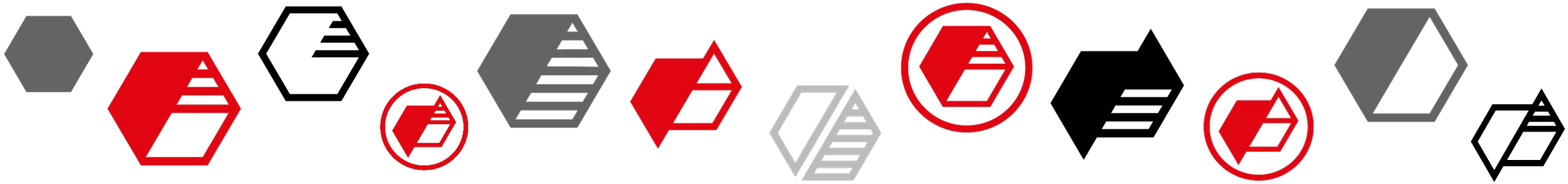
# Test standards – overview

| Testing | Standard |
|---|---|
| Mooney Viscosity ML 1+4 (100 °C) | DIN ISO 289-1 |
| Mooney Scorch ML +5 (120 °C) | DIN ISO 289-2 |
| Cure characteristics | DIN 53 529, part 1 – 4 |
| Tensile test | DIN 53 504, S2 |
| Compression set | DIN ISO 815-1, Type B |
| Hardness | DIN ISO 7619-1 |
| Rebound elasticity | DIN 53 512 |
| Tear resistance - Trousers specimen | DIN ISO 34-1, A |
| Resistance to liquid media | DIN ISO 1817 |
| Resistance to air | ISO 188, D |

# Results

→ back to contents

- Garvey extrusion
- Properties of raw compound
  - ¬ Mooney Viscosity ML 1+4 (100 °C)
  - ¬ Mooney Scorch ML +5 (120 °C)
  - ¬ Rotorless Cure Meter, 180 °C
- Properties of vulcanizate
- Hot air aging 168 h / 70 °C
- Hot air aging 168 h / 100 °C
- Immersion in deionized water 168 h / 95 °C



→ back to results

# Garvey extrusion

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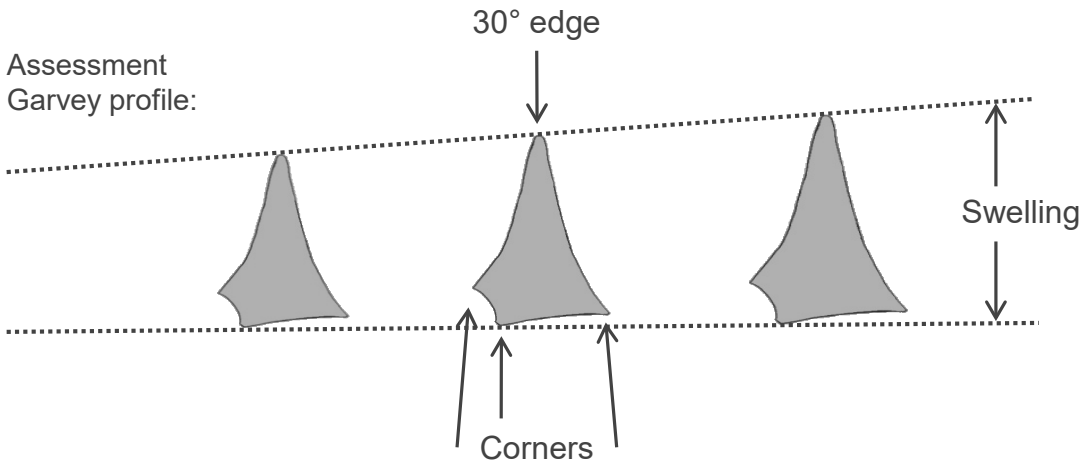
# Garvey extrusion

| Extruder | | Schwabenthan Polyest 30 R |
|---|---|---|
| Screw diameter | [mm] | 30 |
| Process length | [mm] | 450 |
| Temperature set point head / Zone 1 / Zone 2 | [°C] | 150 / 40 / 40 |
| Feeding strips | | cold, untreated |

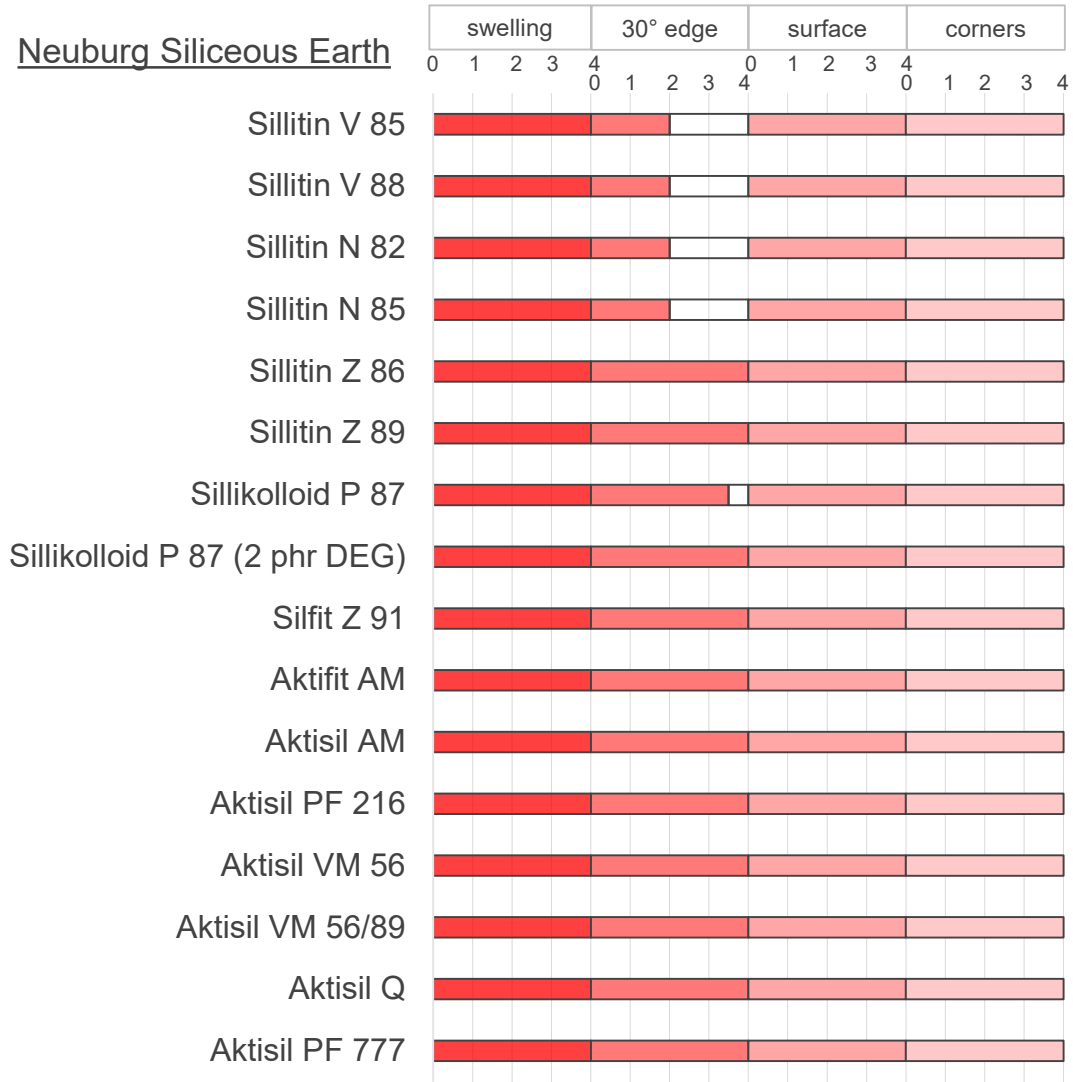


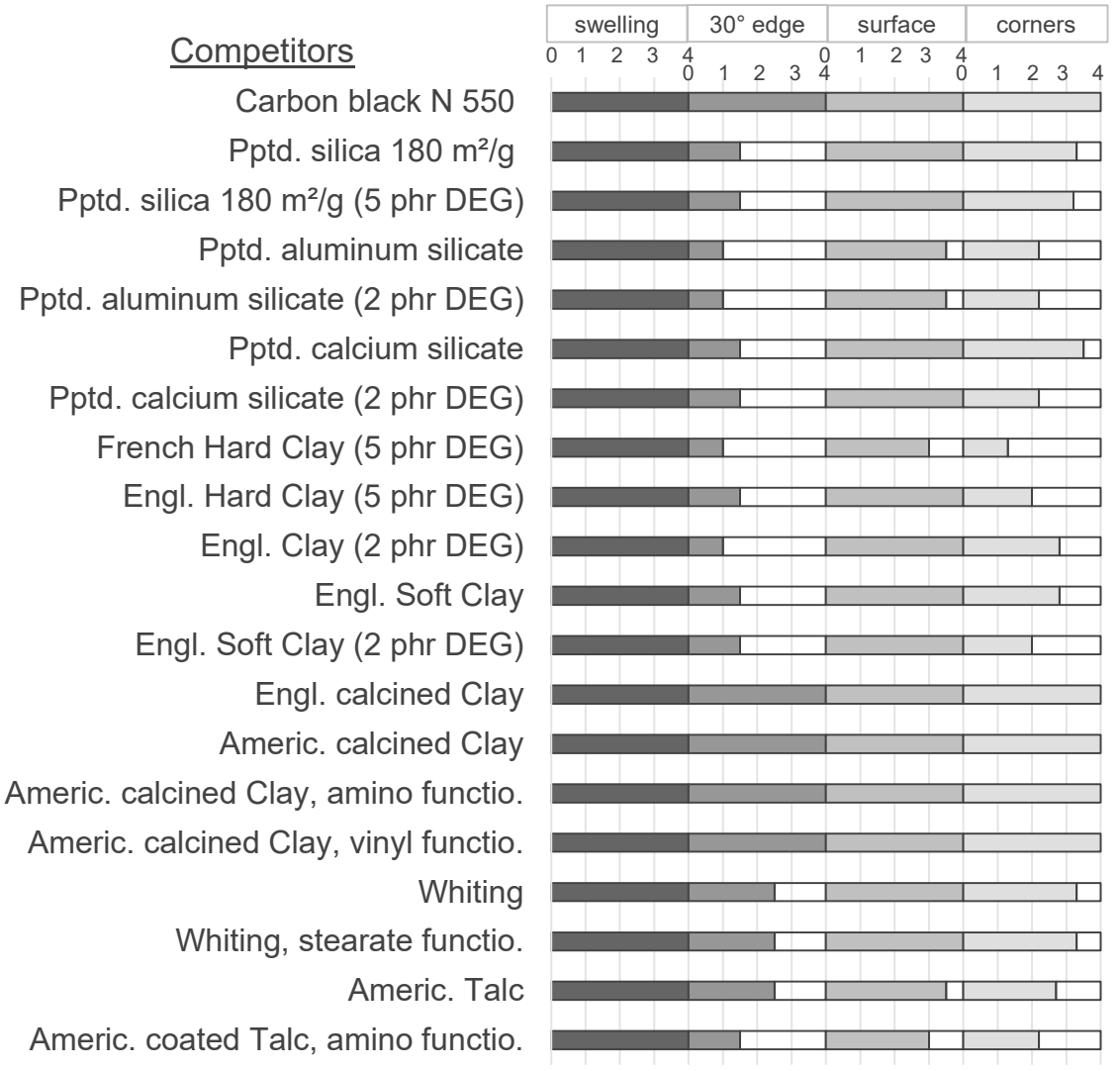

Garvey-die:

# Assessment Garvey profile at 2.0 m/min. haul-off speed

according to ASTM D 2230-90

Images
Garvey-Extrudate

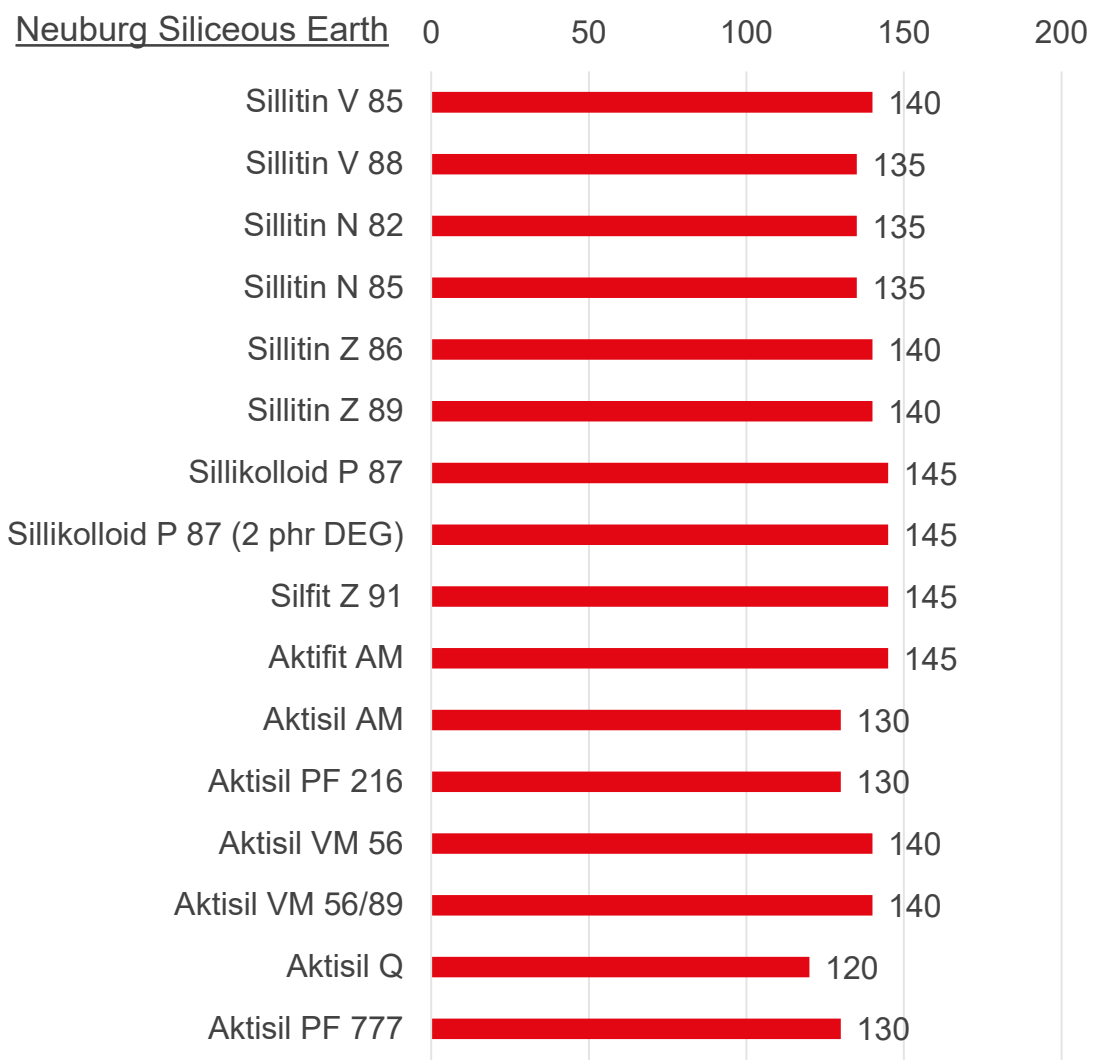


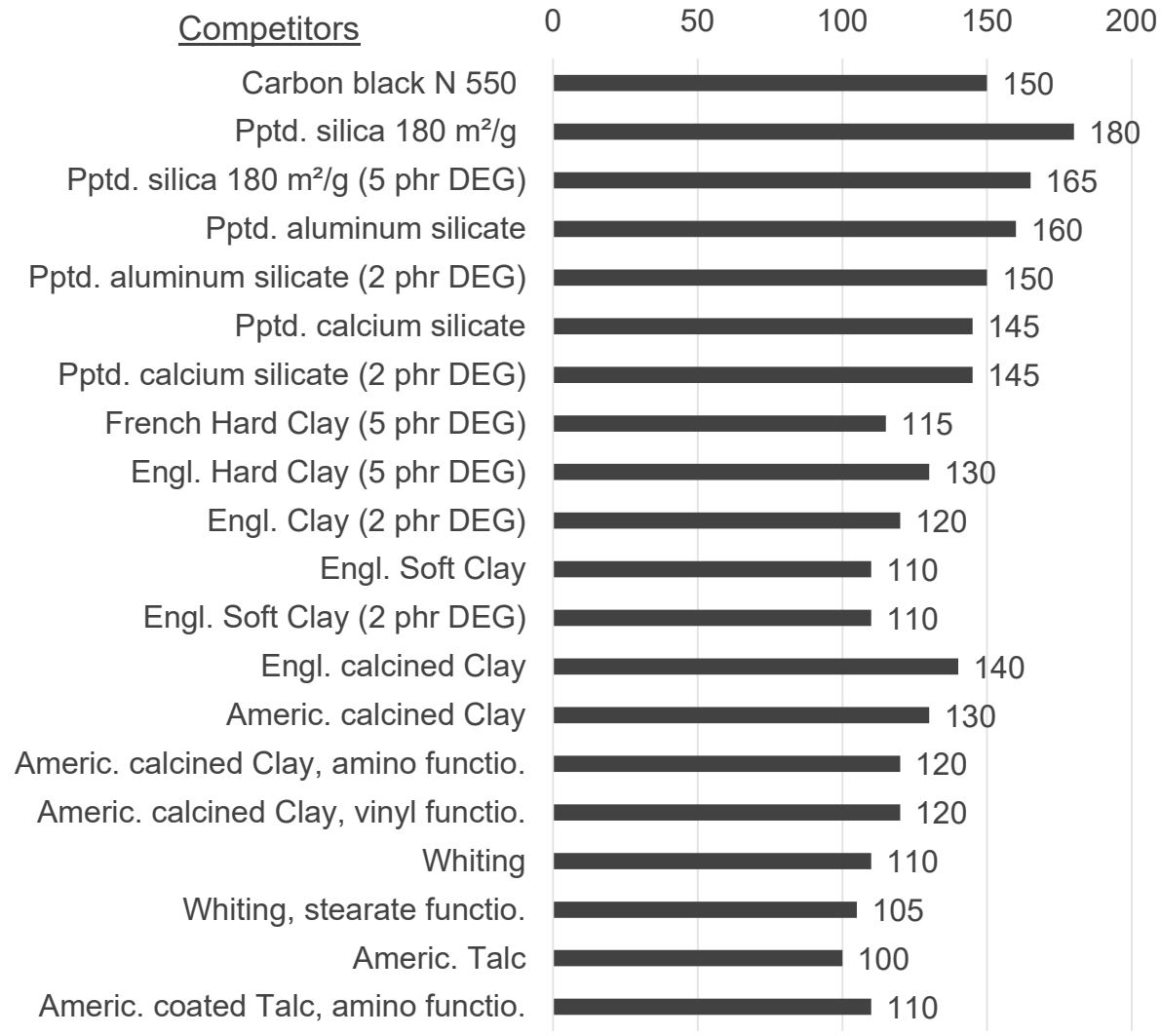






Note: Sillitin N 82 will be replaced by Sillitin N 75

# Extruder torque at 2.0 m/min. in Nm






Note: Sillitin N 82 will be replaced by Sillitin N 75

# Max. Extrusion speed with Garvey profile 4444
# Haul-off speed in m/min.


* higher speed possible

Note: Sillitin N 82 will be replaced by Sillitin N 75

# Max. Extrusion speed with Garvey profile 4444
# Extruder torque in Nm


**Note: Sillitin N 82 will be replaced by Sillitin N 75**

# Summary Garvey extrusion:

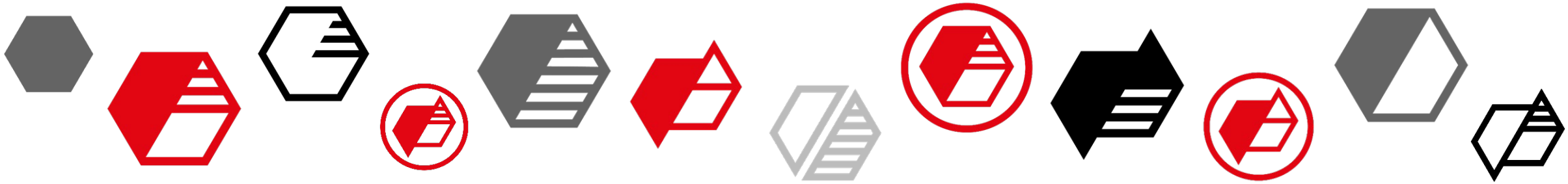
Special features of Neuburg Siliceous Earth in peroxide-cured EPDM rubber for extrusion application (Sillitin, Aktisil, Silfit, Aktifit)

**Neuburg Siliceous Earth has positive characteristics:**
Compared to the competitors, twice as many NSE products achieve the 4444-Garvey rating at the same haul-off speed.
Comparable extruder torque with higher haul-off speed with functional and/or calcined NSE versus calcined (and functionalized) kaolin

**Garvey rating at 2.0 m/min. haul-off speed:**
- almost all Neuburg Siliceous Earth grades achieve the full 4444-Garvey profile rating
- average extruder torque is 135 Nm
- lowest extruder torque with 4444-Garvey profile rating achieved Aktisil Q with 120 Nm

**Garvey profile at maximum extrusion speed with 4444 rating:**
- maximum haul-off speed achieved Aktifit AM with 10 m/min.
- average extruder torque is 155 Nm
- lowest extruder torque with 4444-Garvey profile rating achieved Aktisil MAM with 130 Nm

**DEG Addition:**
The DEG addition to Sillikolloid P 87 made it possible to achieve a 4444-Garvey profile rating.
The maximum haul-off speed for a 4444 rating could be increased twofold.



→ back to results

# Properties of raw compound

DIN ISO 289-1
DIN ISO 289-2
DIN 53 529, part 1 – 4

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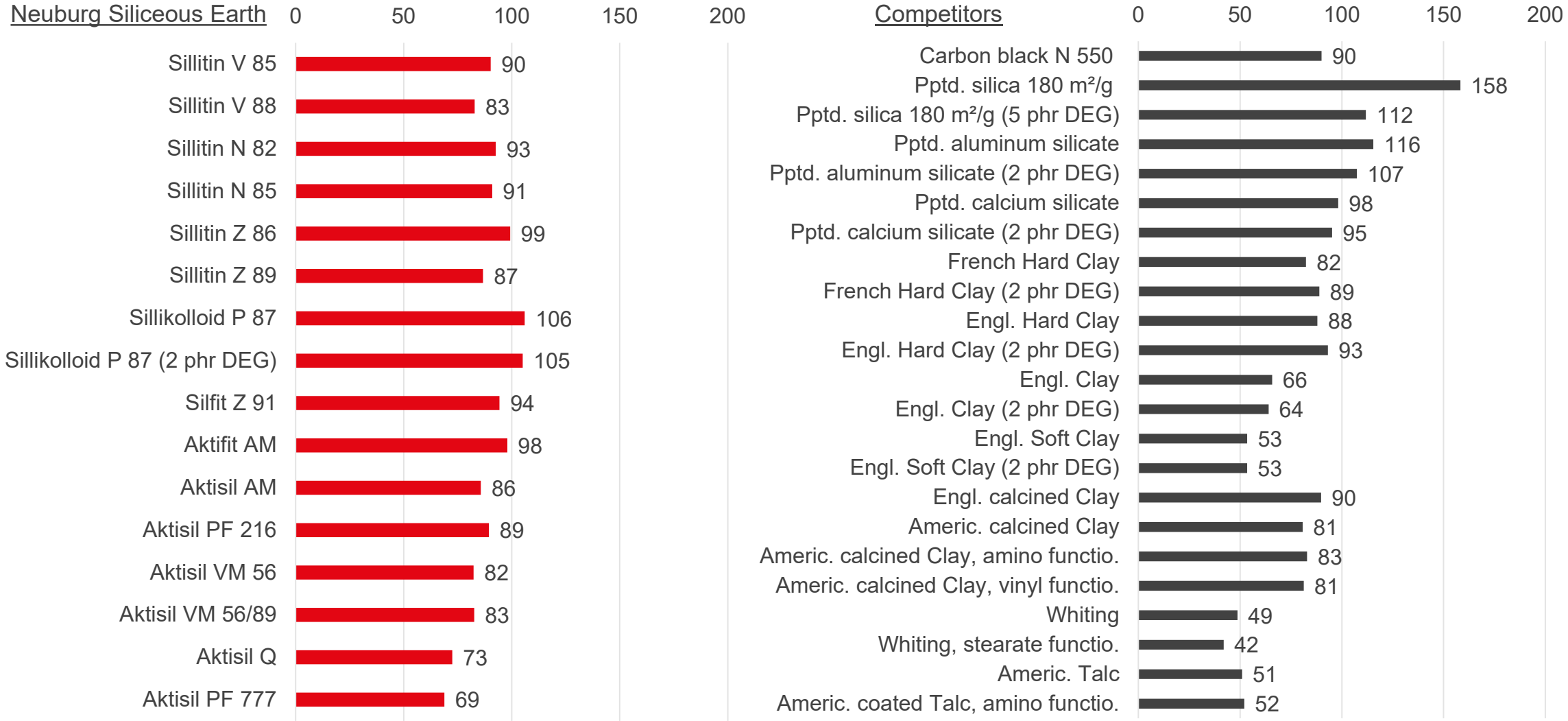
# Mooney Viskosität ML 1+4 (100 °C) in MU

DIN ISO 289-1

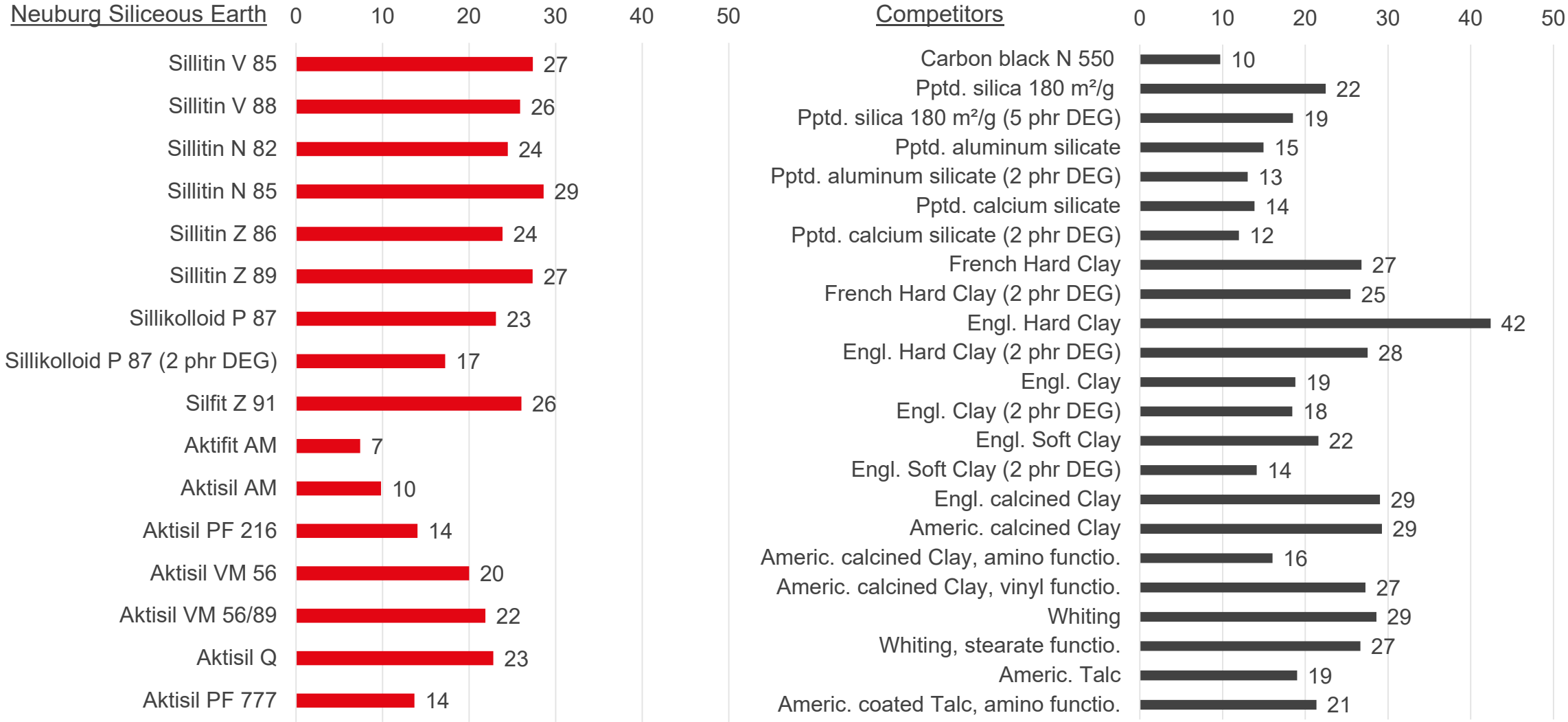





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Mooney Scorch ML +5 (120 °C) in min.

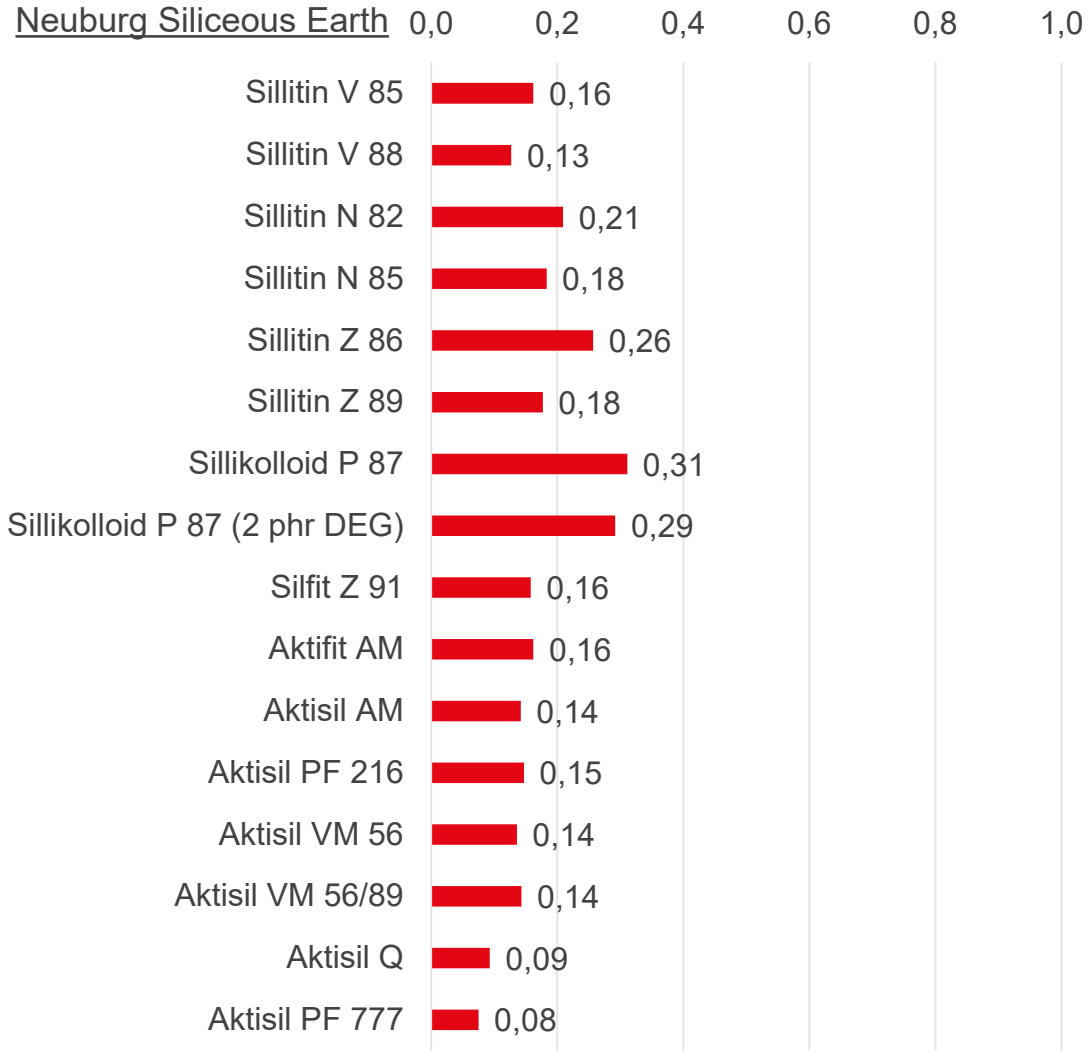
DIN ISO 289-2

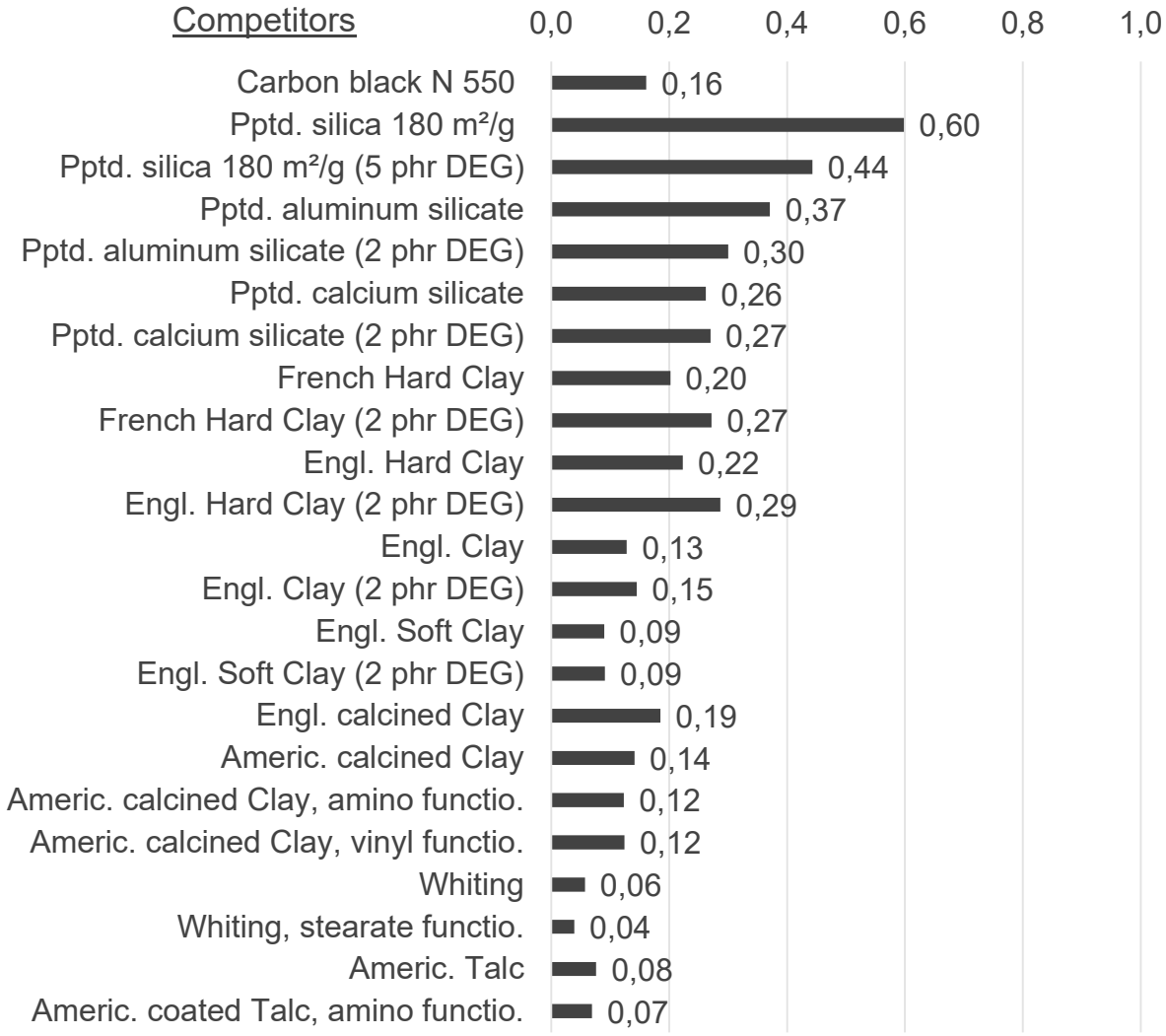





**Note: Sillitin N 82 will be replaced by Sillitin N 75**

# Rotorless curemeter, 180 °C
# Torque minimum in Nm

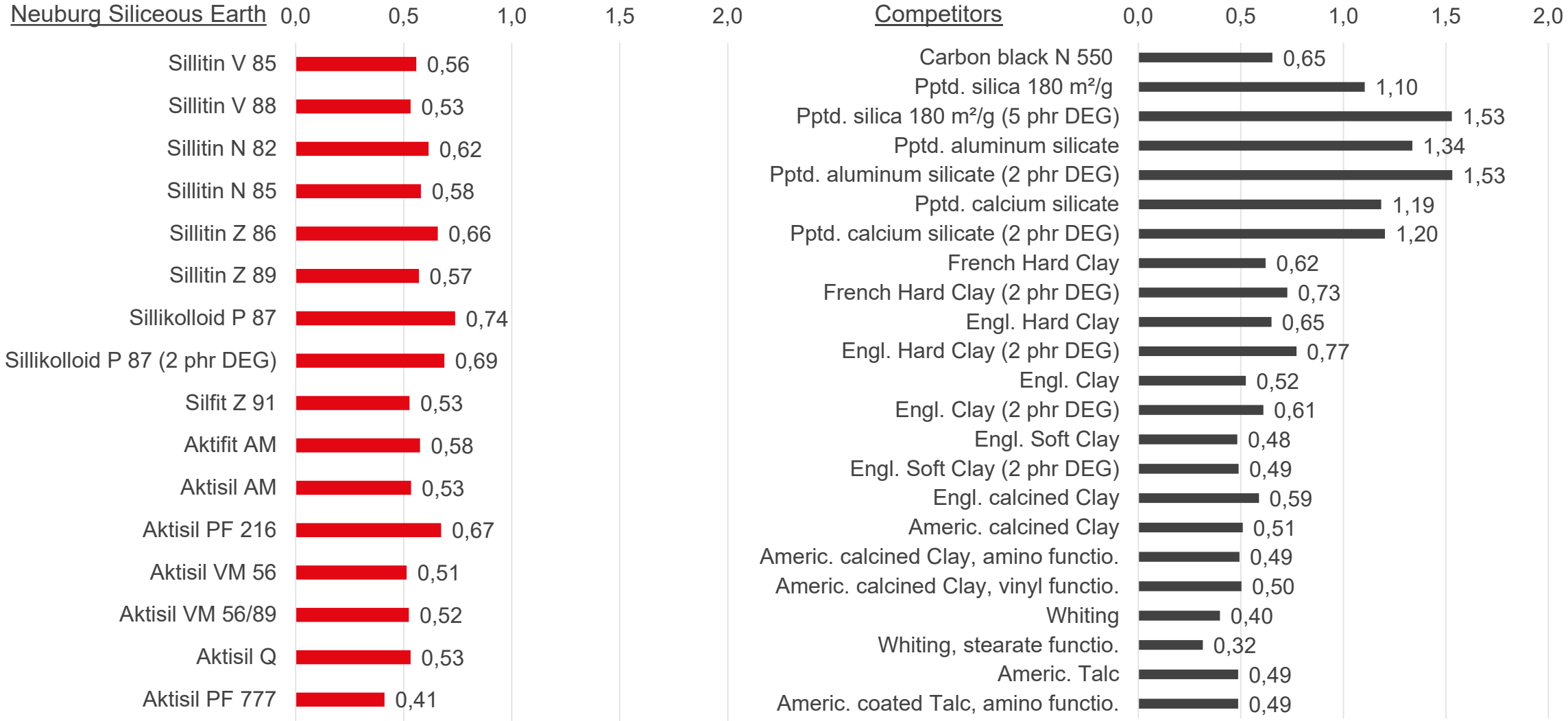





Note: Sillitin N 82 will be replaced by Sillitin N 75

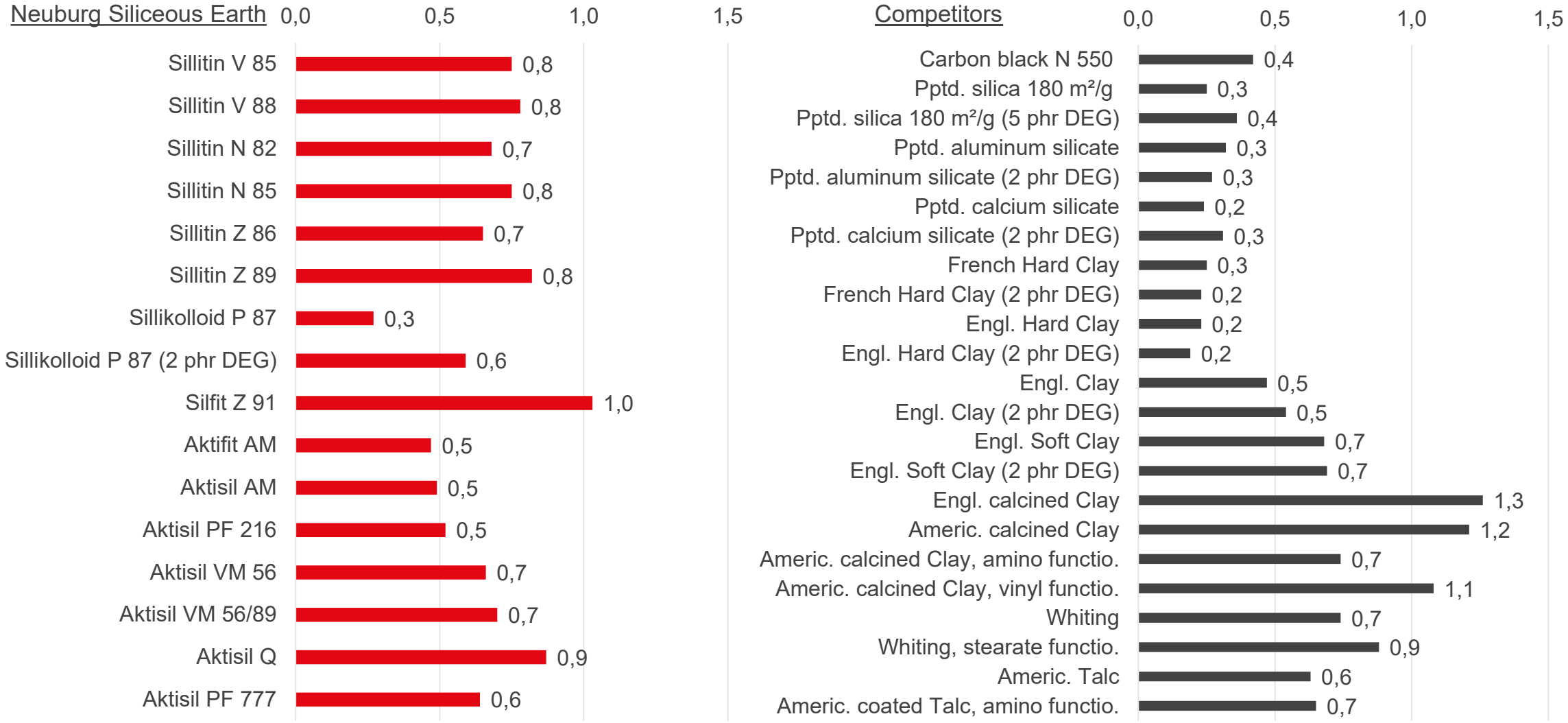
# Rotorless curemeter, 180 °C
# Cure yield in Nm






Note: Sillitin N 82 will be replaced by Sillitin N 75

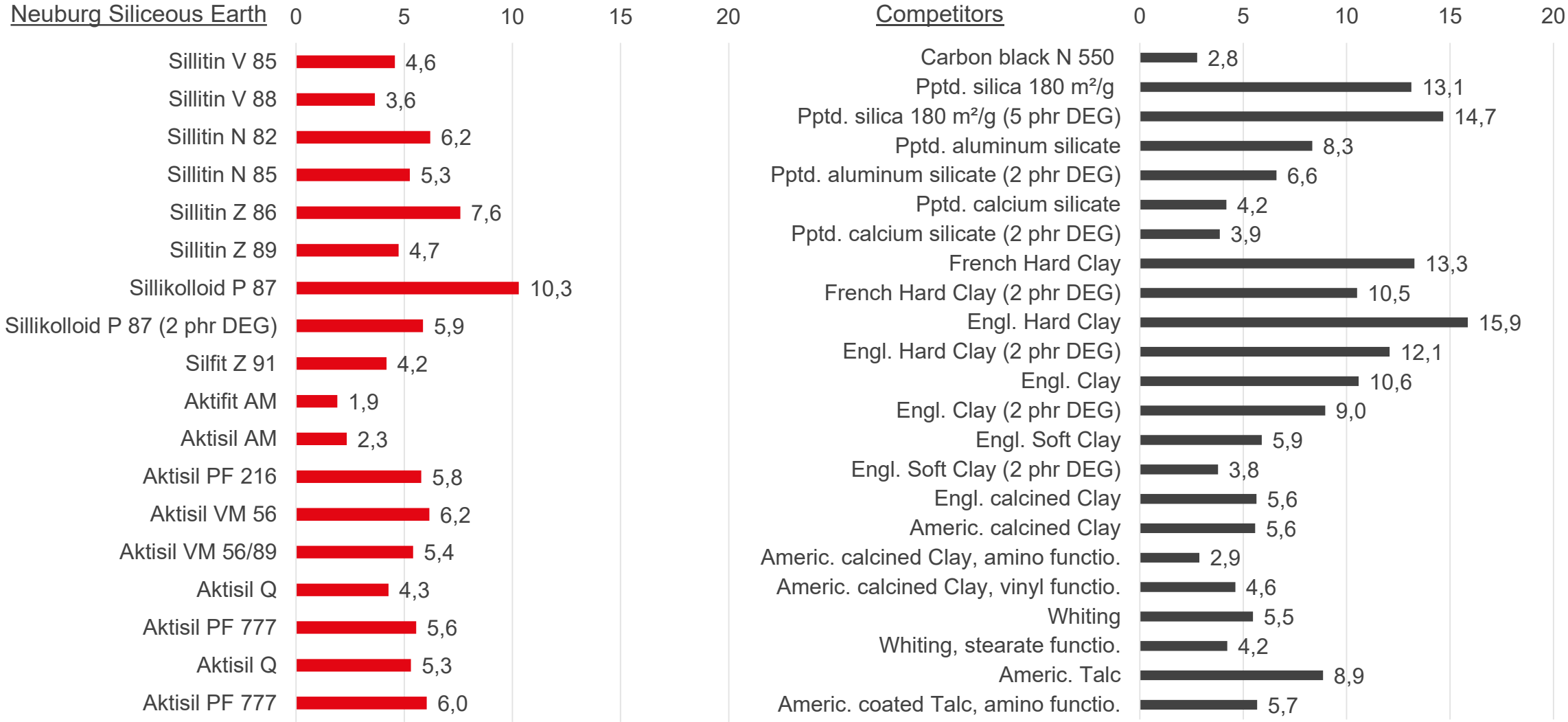
# Rotorless curemeter, 180 °C
# Conversion time $t_5$ in min.






Note: Sillitin N 82 will be replaced by Sillitin N 75

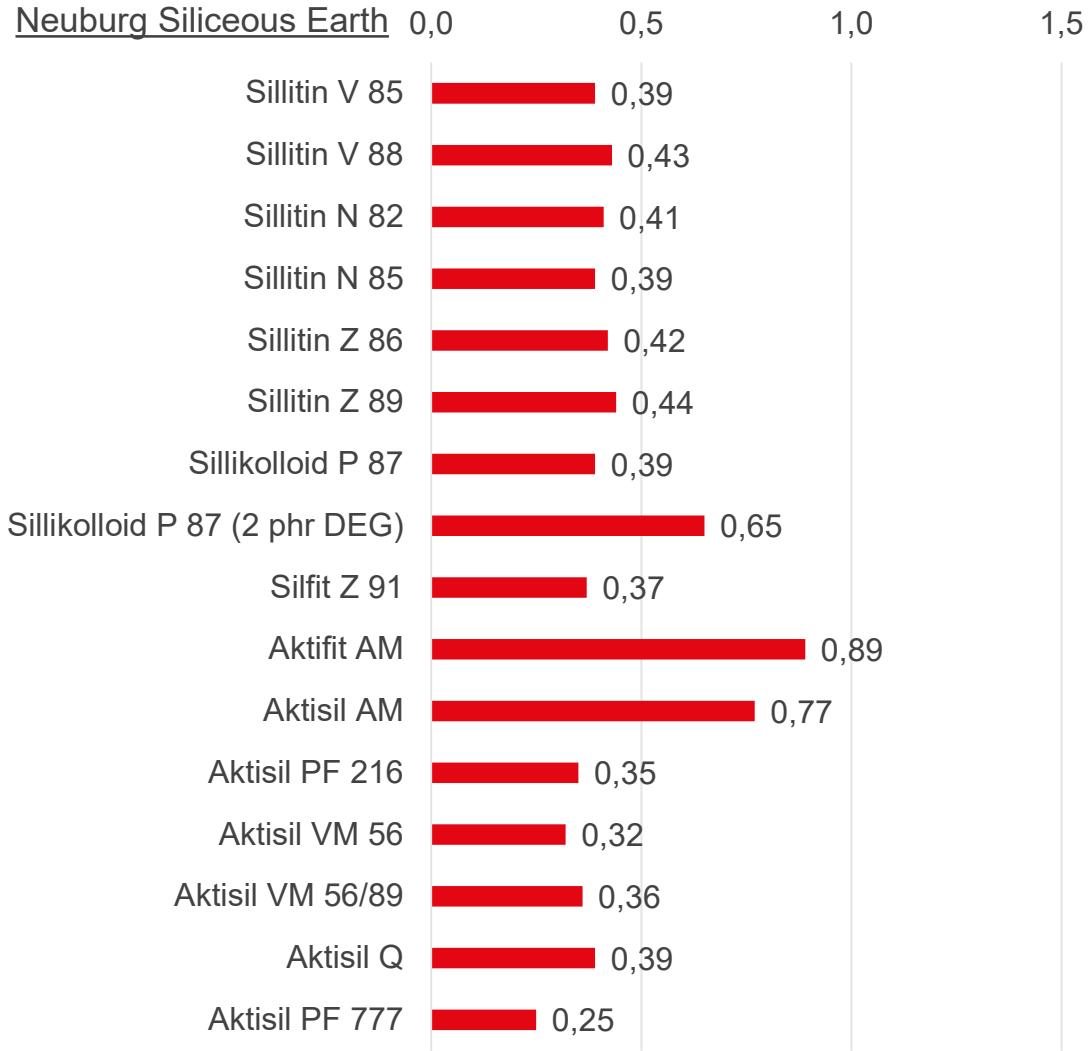
# Rotorless curemeter, 180 °C
# Conversion time $t_{90}$ in min.

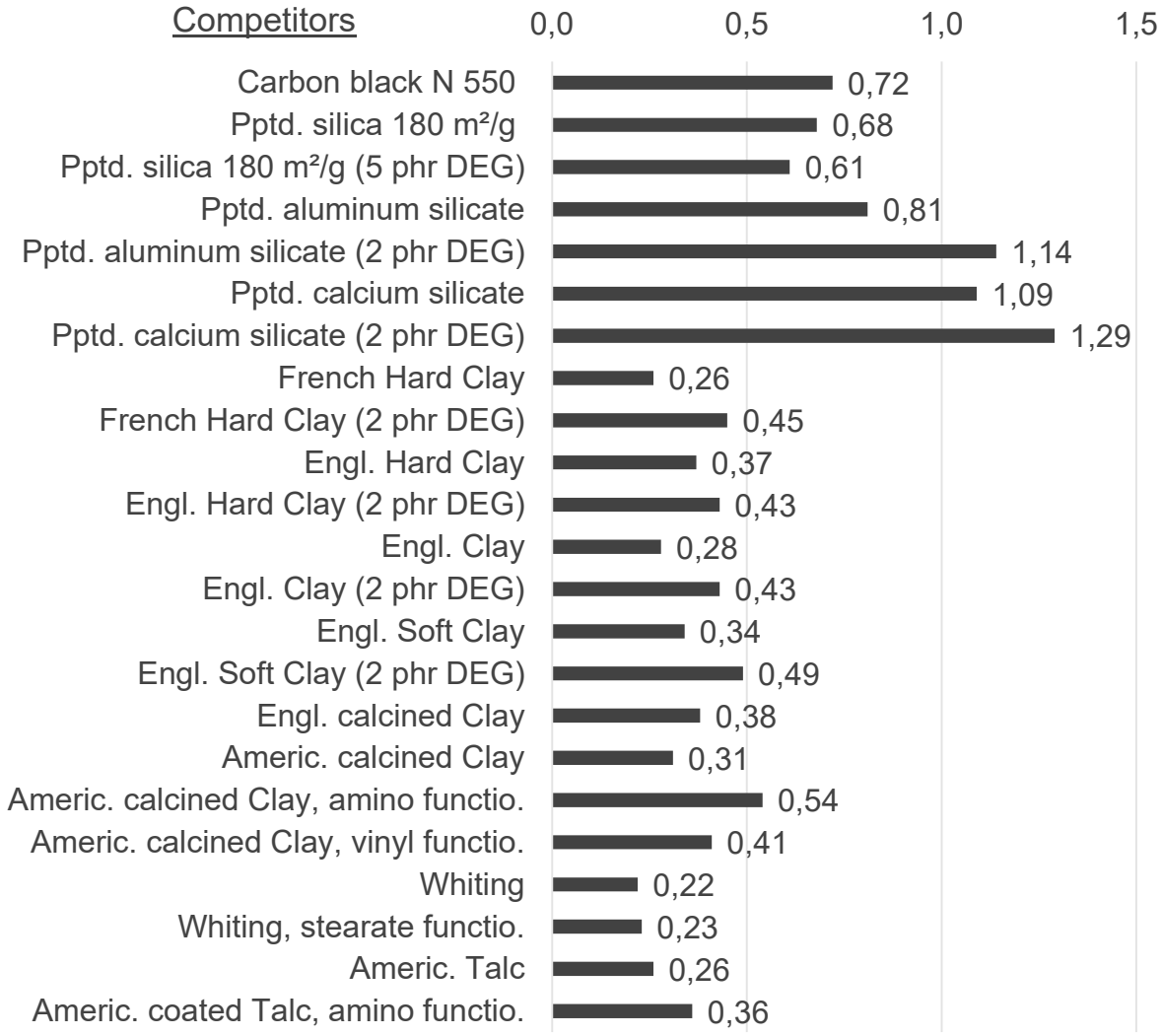





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Rotorless curemeter, 180 °C
# Max. speed of cure in Nm/min.

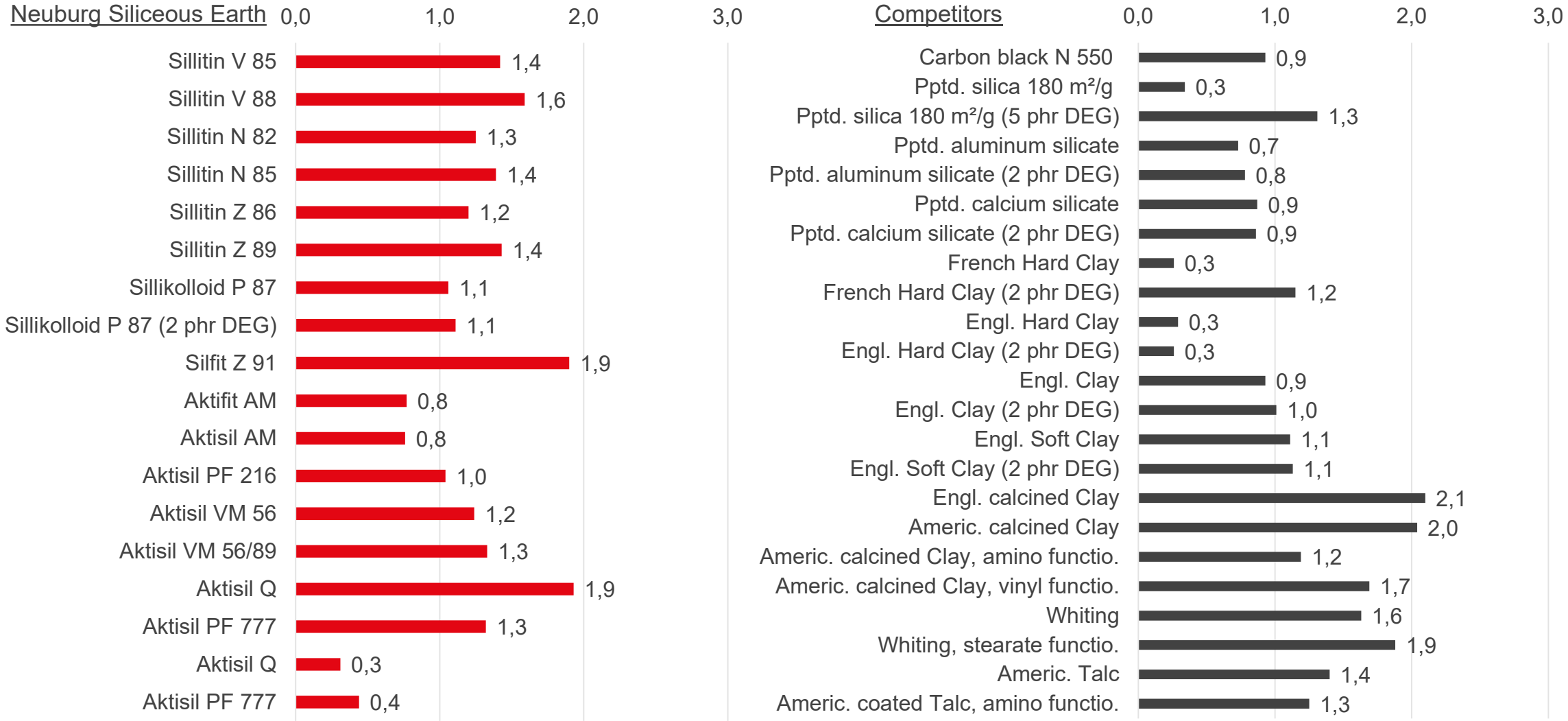





Note: Sillitin N 82 will be replaced by Sillitin N 75

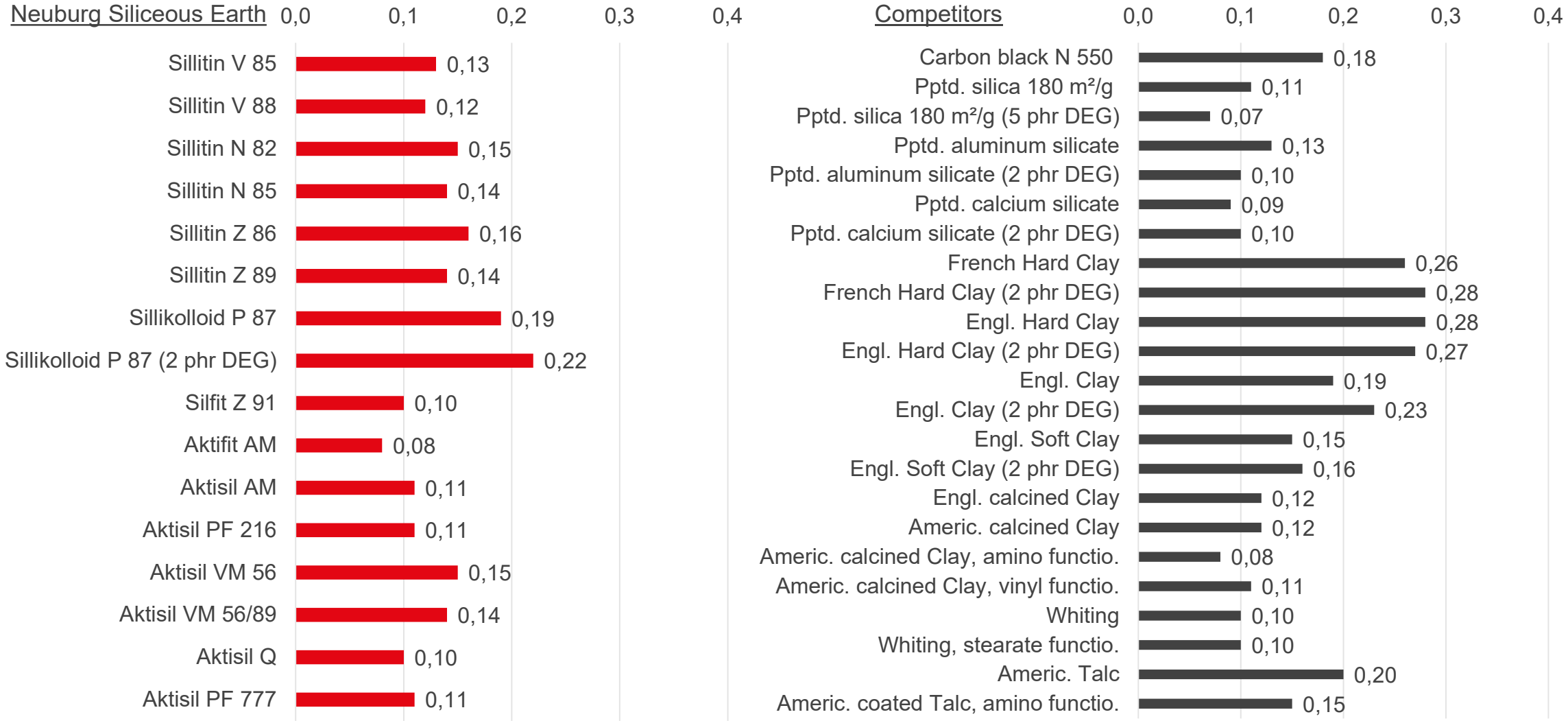
# Rotorless curemeter, 180 °C
# Time until max. speed of cure in min.





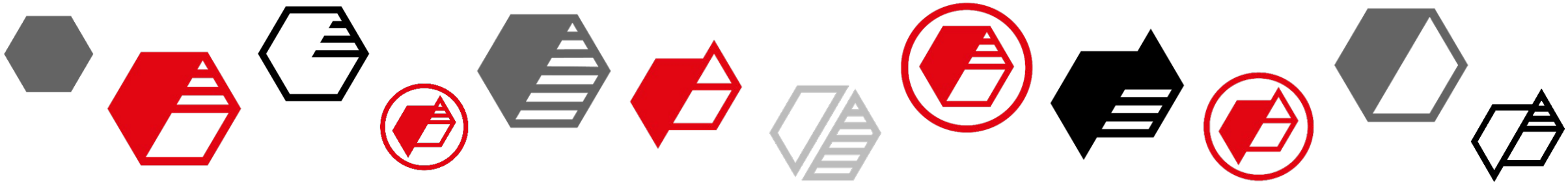

Note: Sillitin N 82 will be replaced by Sillitin N 75

# Rotorless curemeter, 180 °C
# tan δ, end of test






Note: Sillitin N 82 will be replaced by Sillitin N 75



→ back to results

# Properties of vulcanizate

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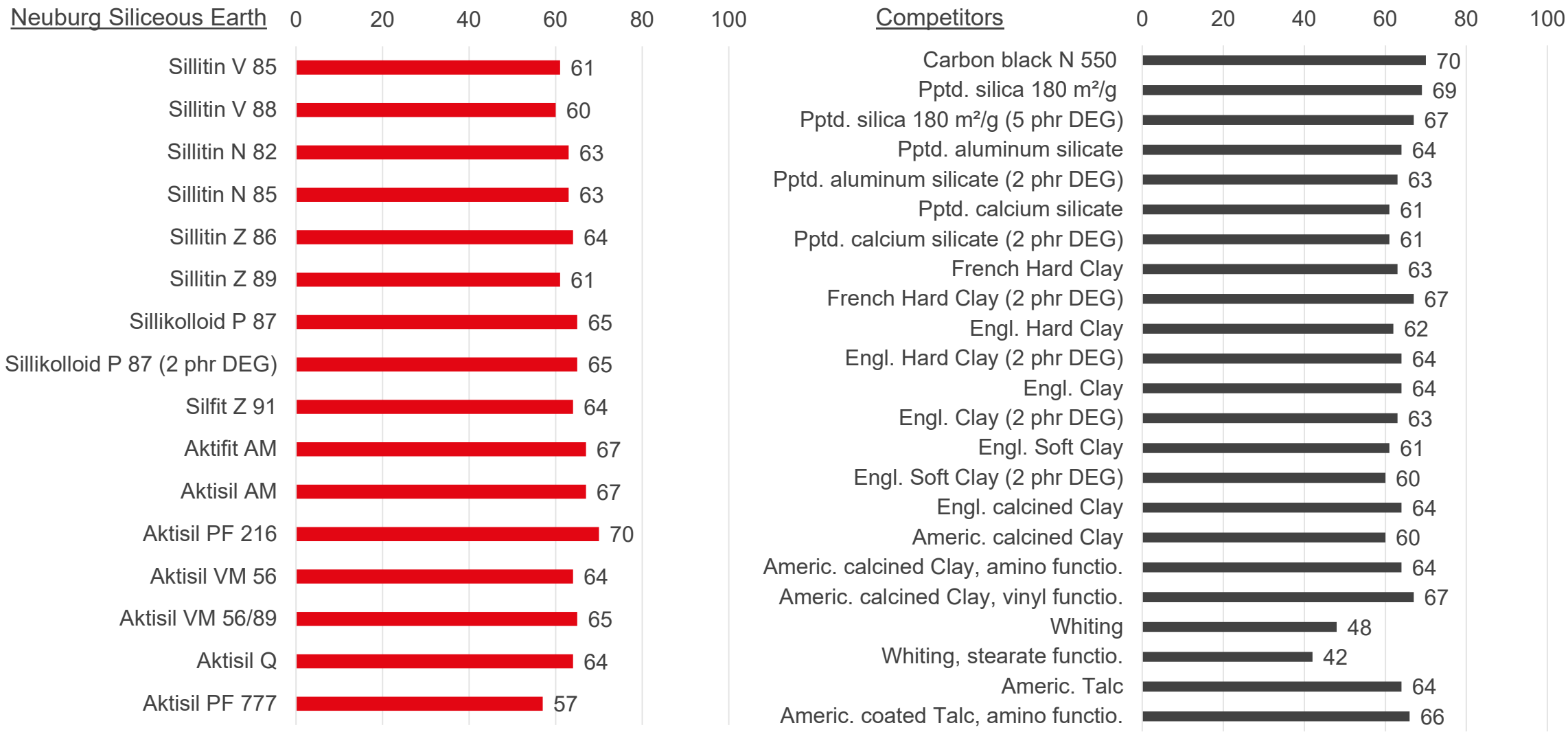
# Hardness – piled-up S2 dumbbells

DIN ISO 7619-1

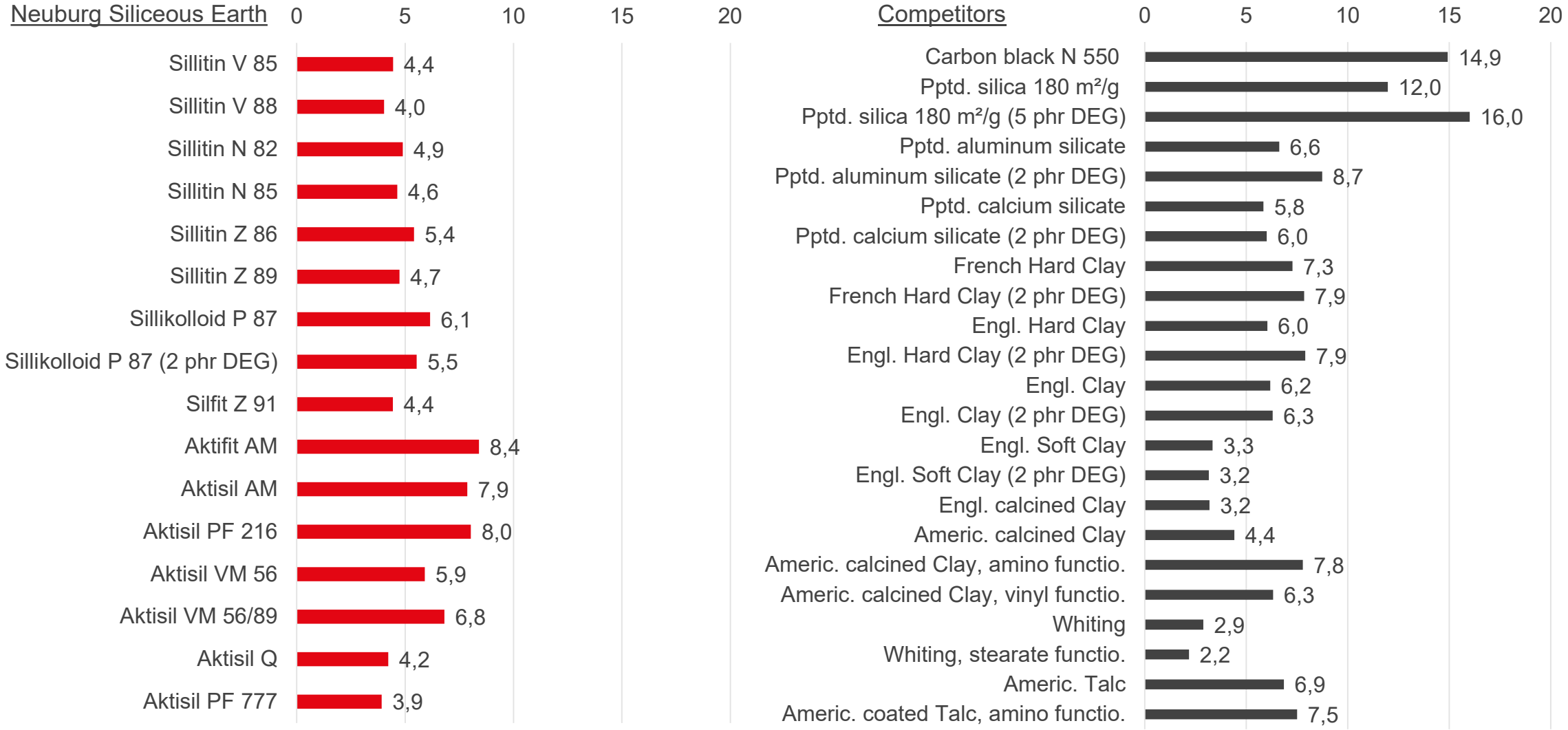





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Tensile strength in MPa

DIN 53 504, S2

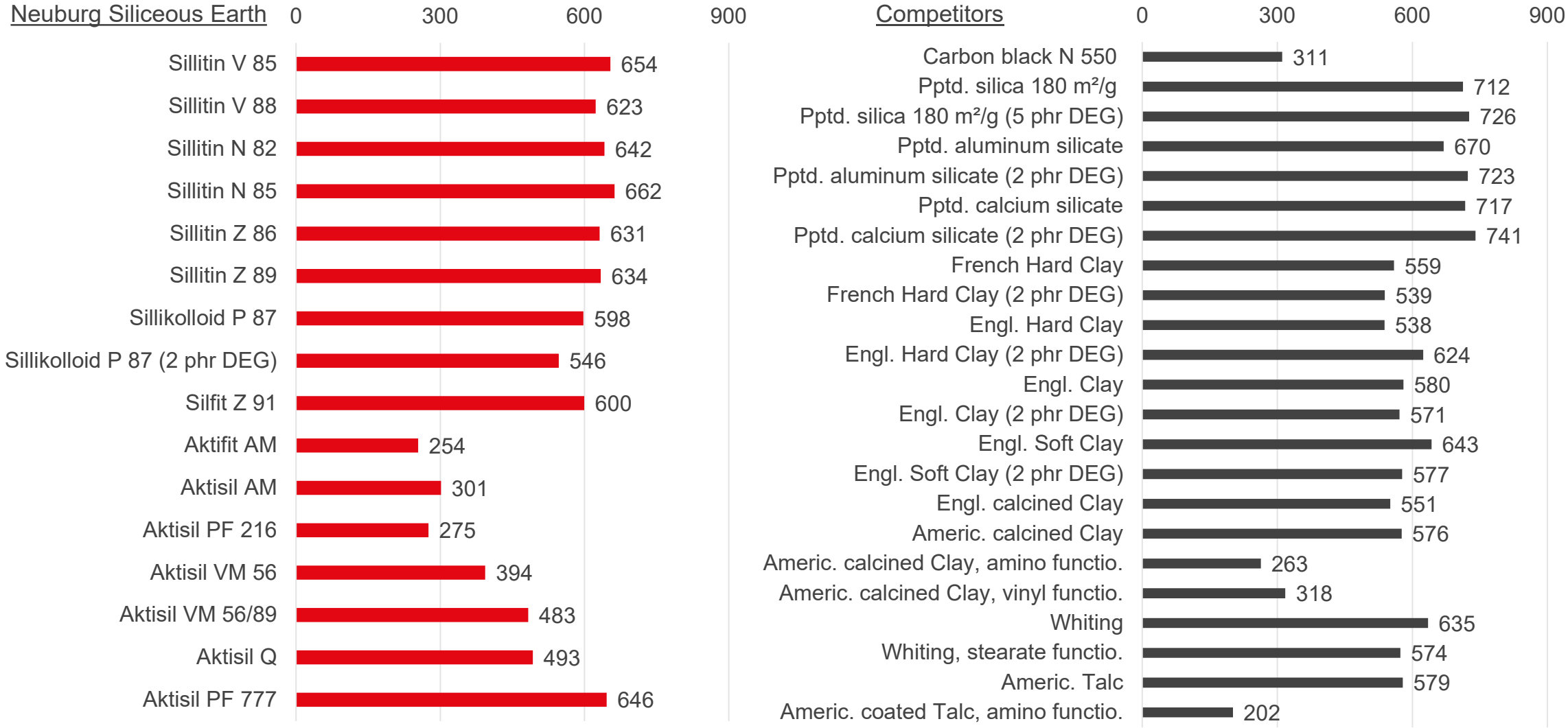





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Elongation at break in %

DIN 53 504, S2

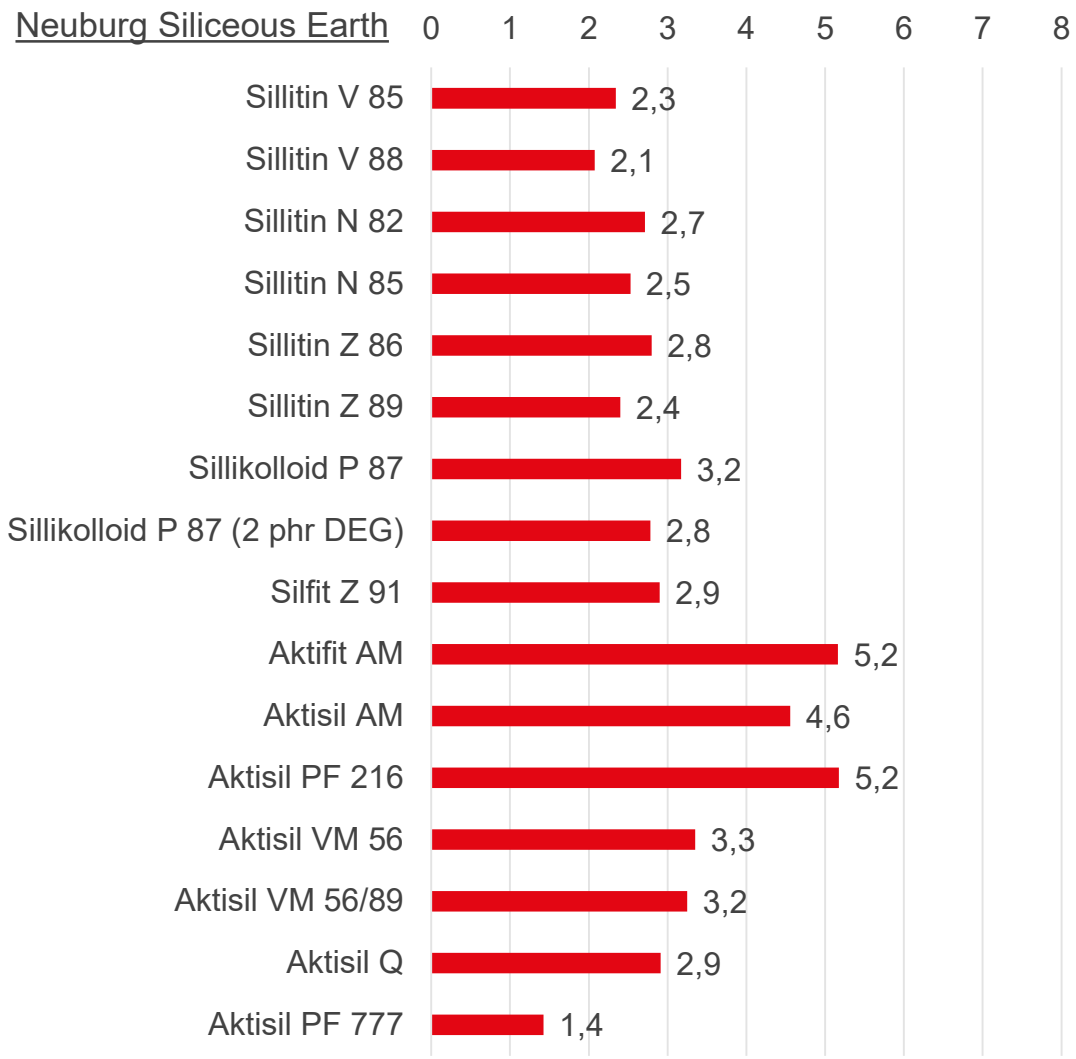


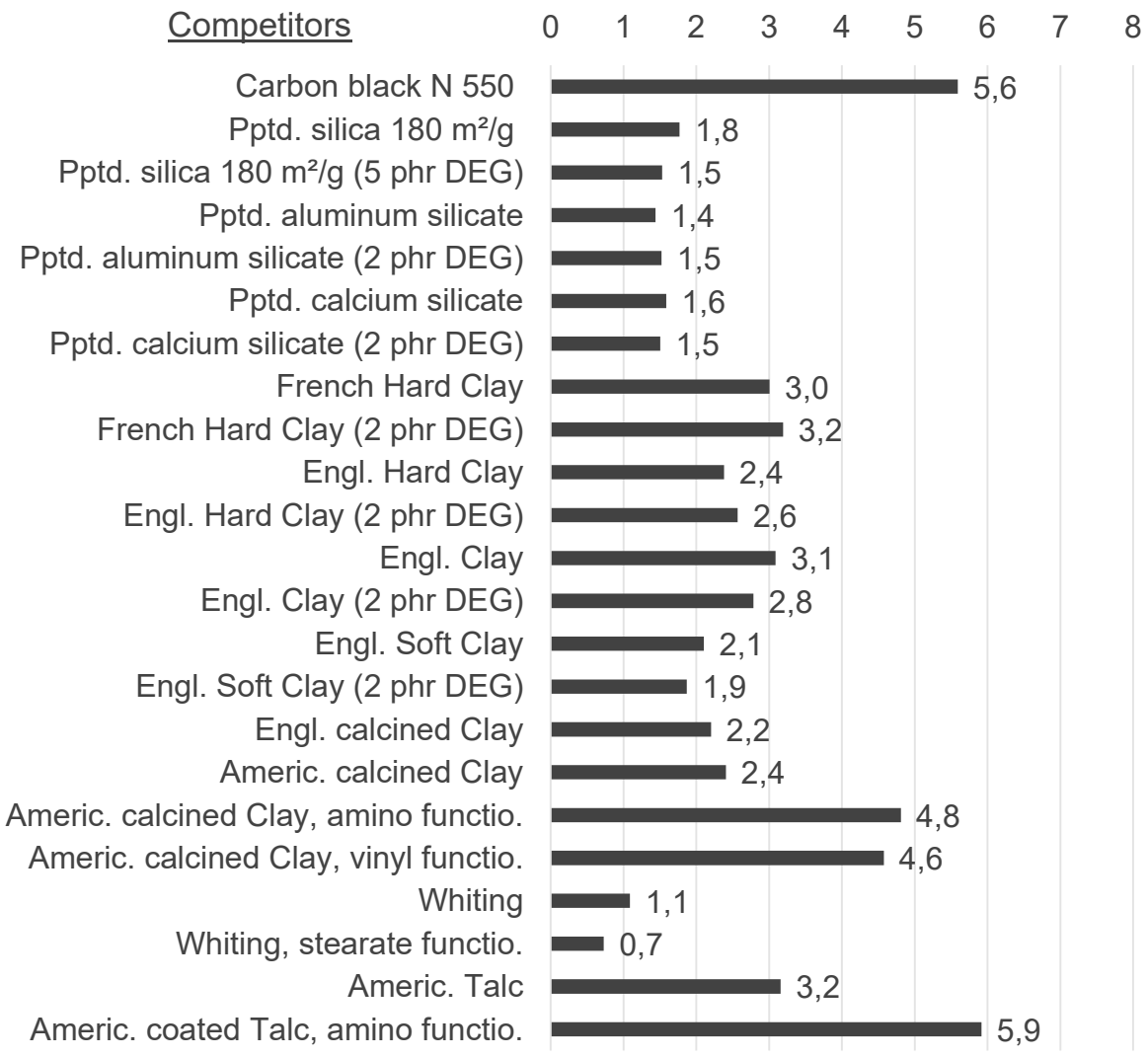



Note: Sillitin N 82 will be replaced by Sillitin N 75

# Modulus 100 % in MPa

DIN 53 504, S2



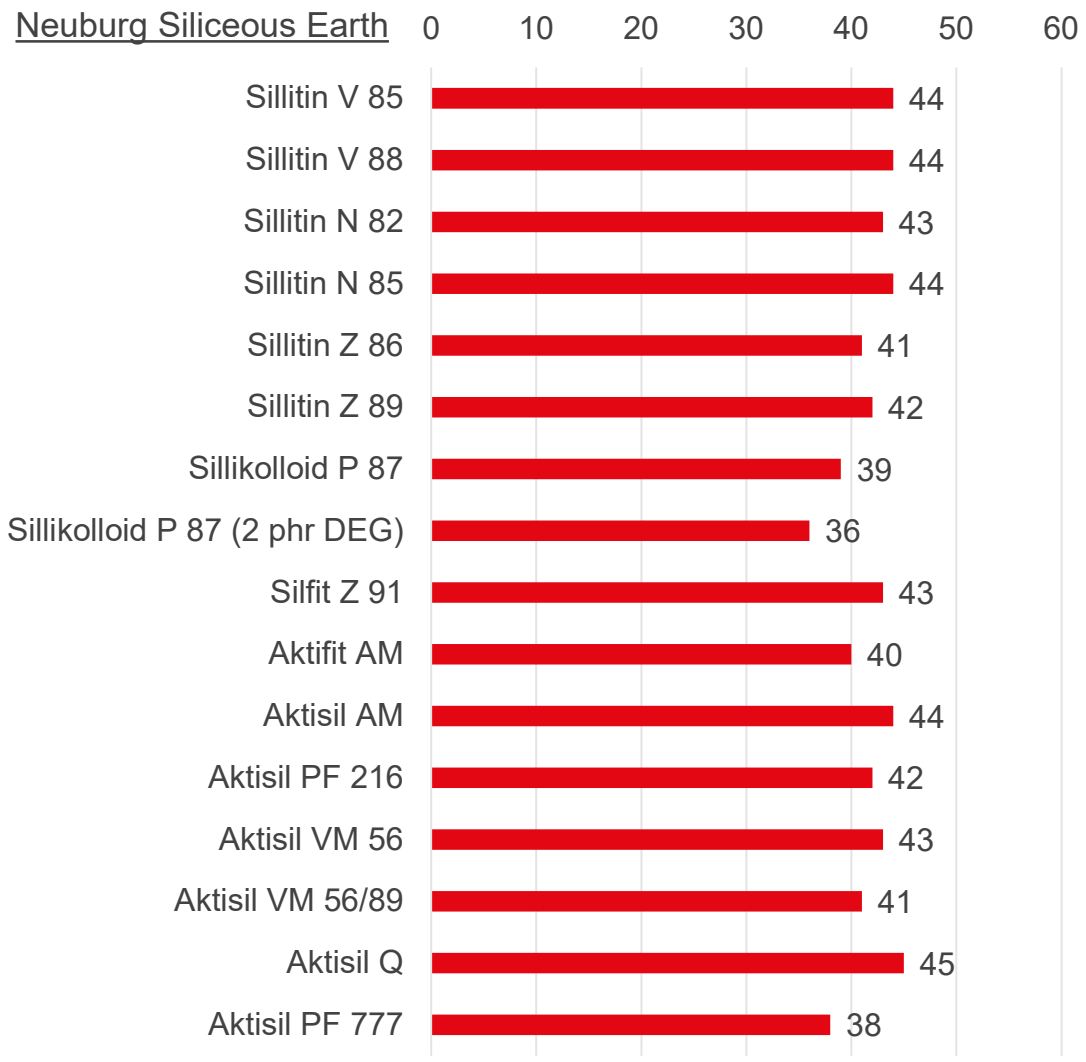



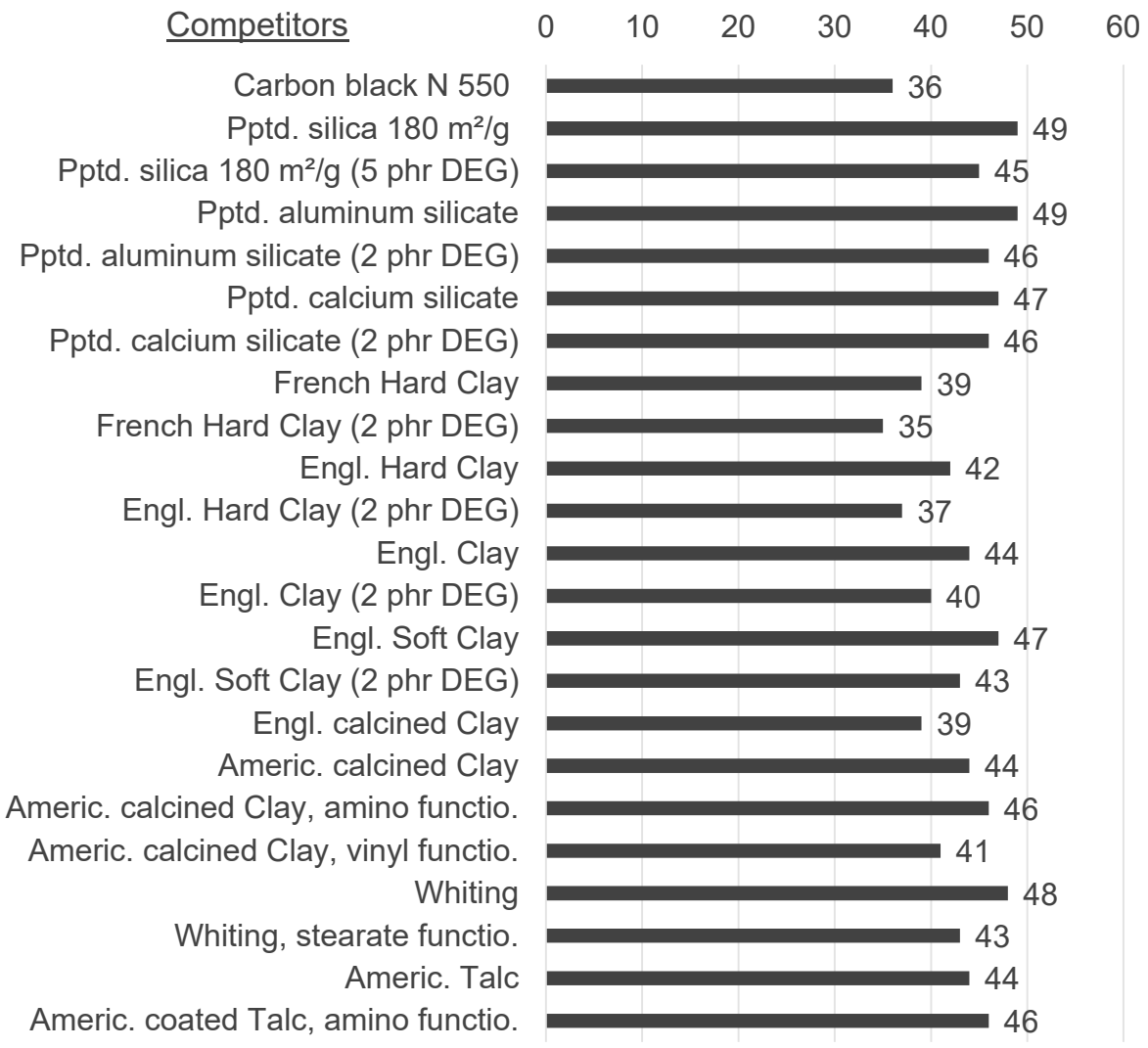



Note: Sillitin N 82 will be replaced by Sillitin N 75

# Rebound elasticity in %

DIN 53 512



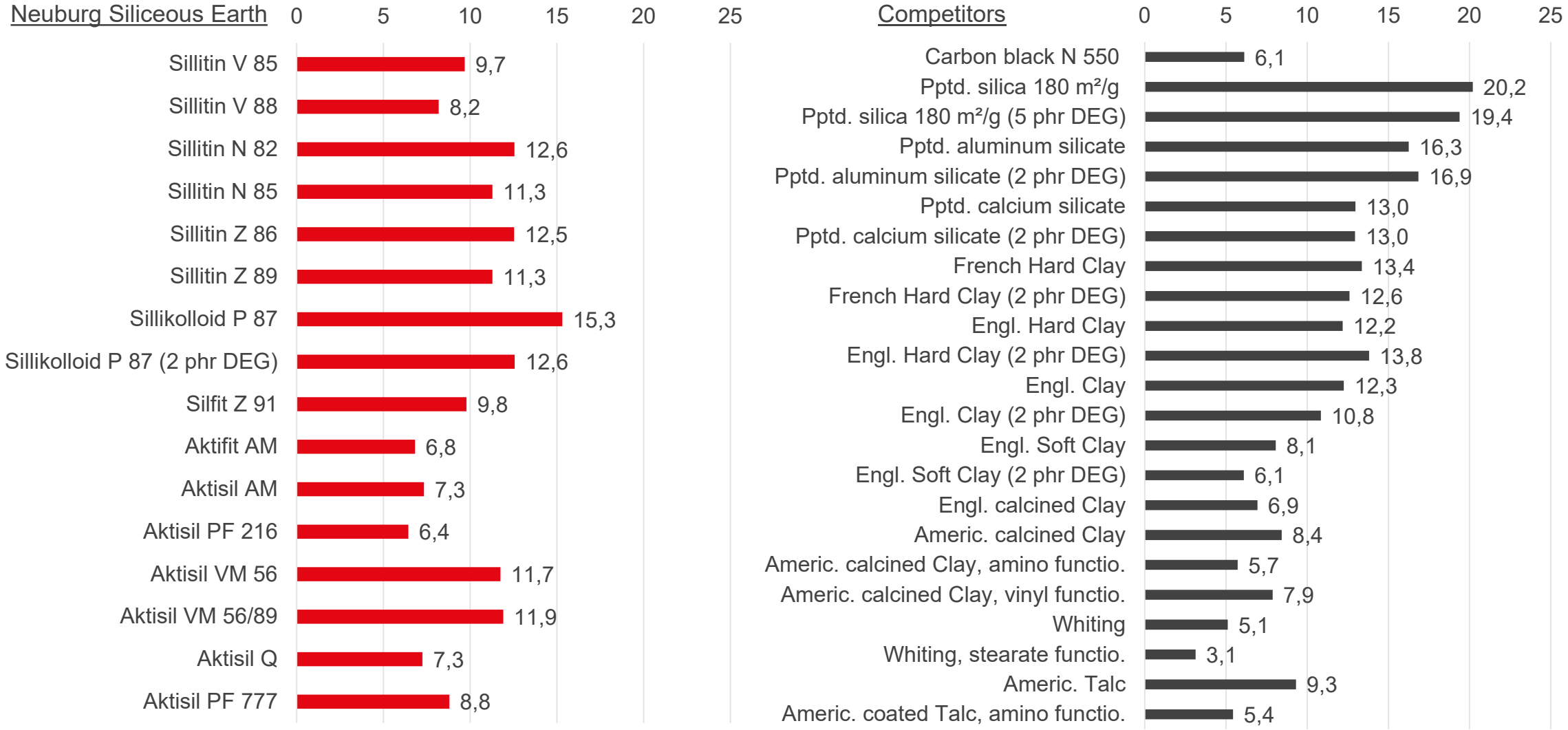






Note: Sillitin N 82 will be replaced by Sillitin N 75

# Tear resistance in N/mm – Trousers specimen

DIN ISO 34-1, A

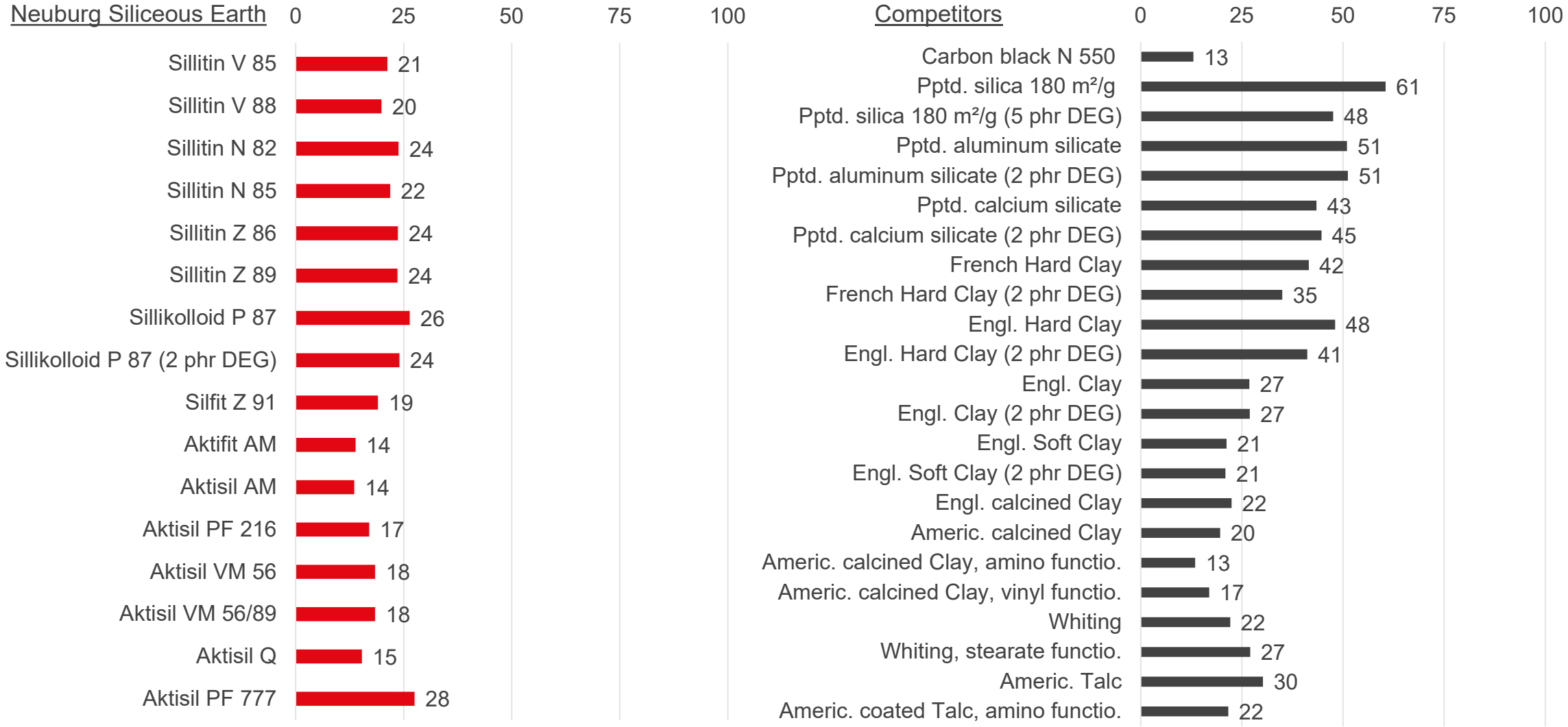





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Compression set in % (24 h / 70 °C / 25 % Def.)

DIN ISO 815-1, Type B

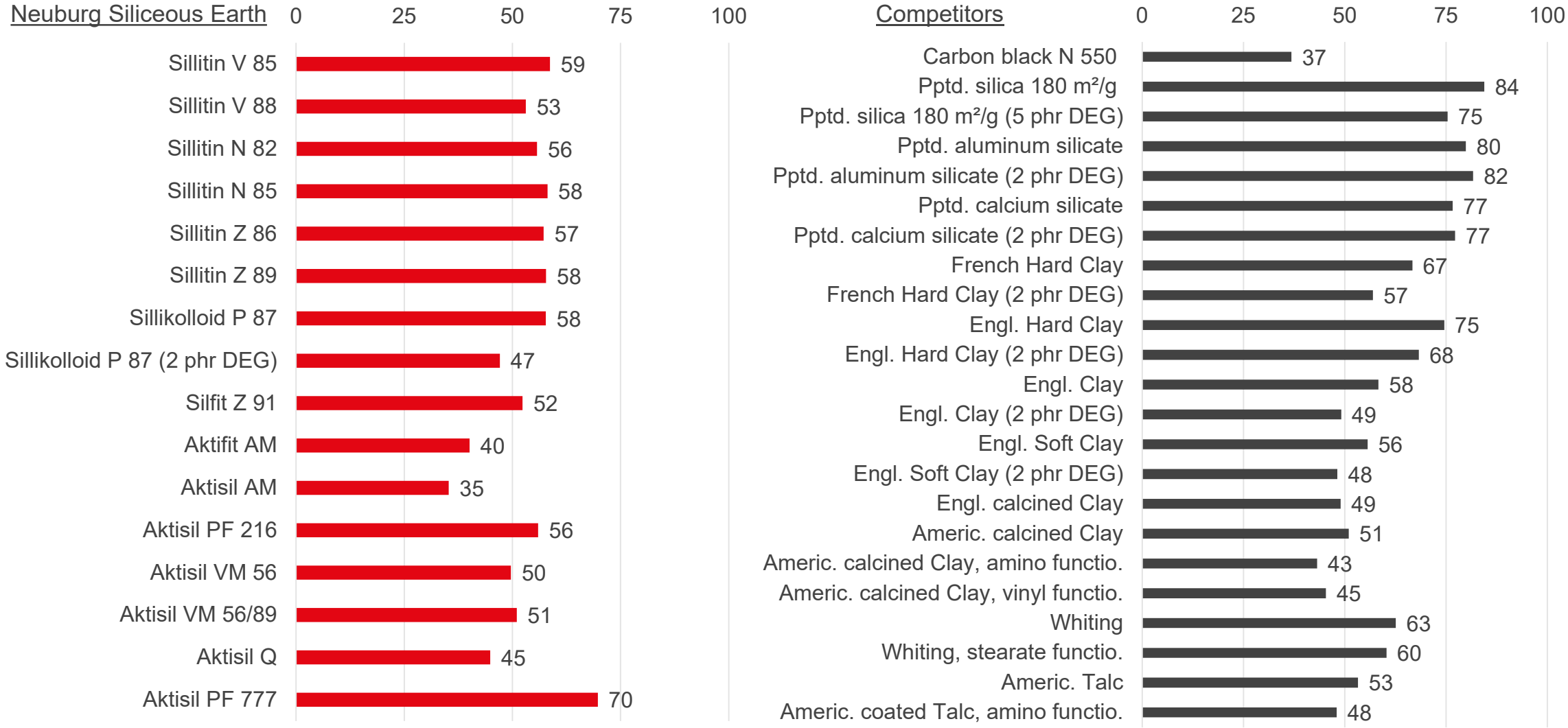




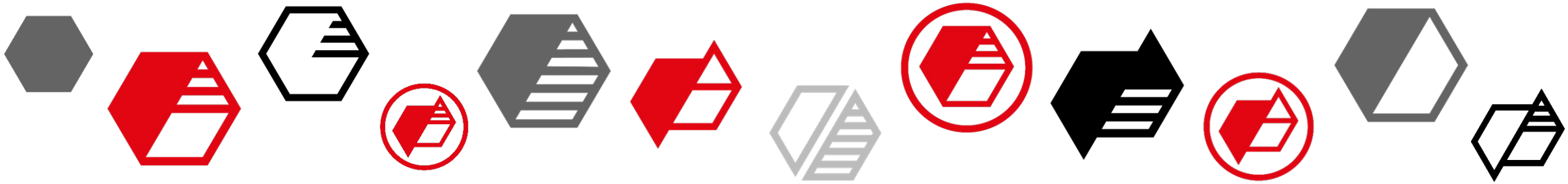

Note: Sillitin N 82 will be replaced by Sillitin N 75

# Compression set in % (24 h / 100 °C / 25 % Def.)

DIN ISO 815-1, Type B




Note: Sillitin N 82 will be replaced by Sillitin N 75



→ back to results

# Hot air aging 168 h / 70 °C

ISO 188, D

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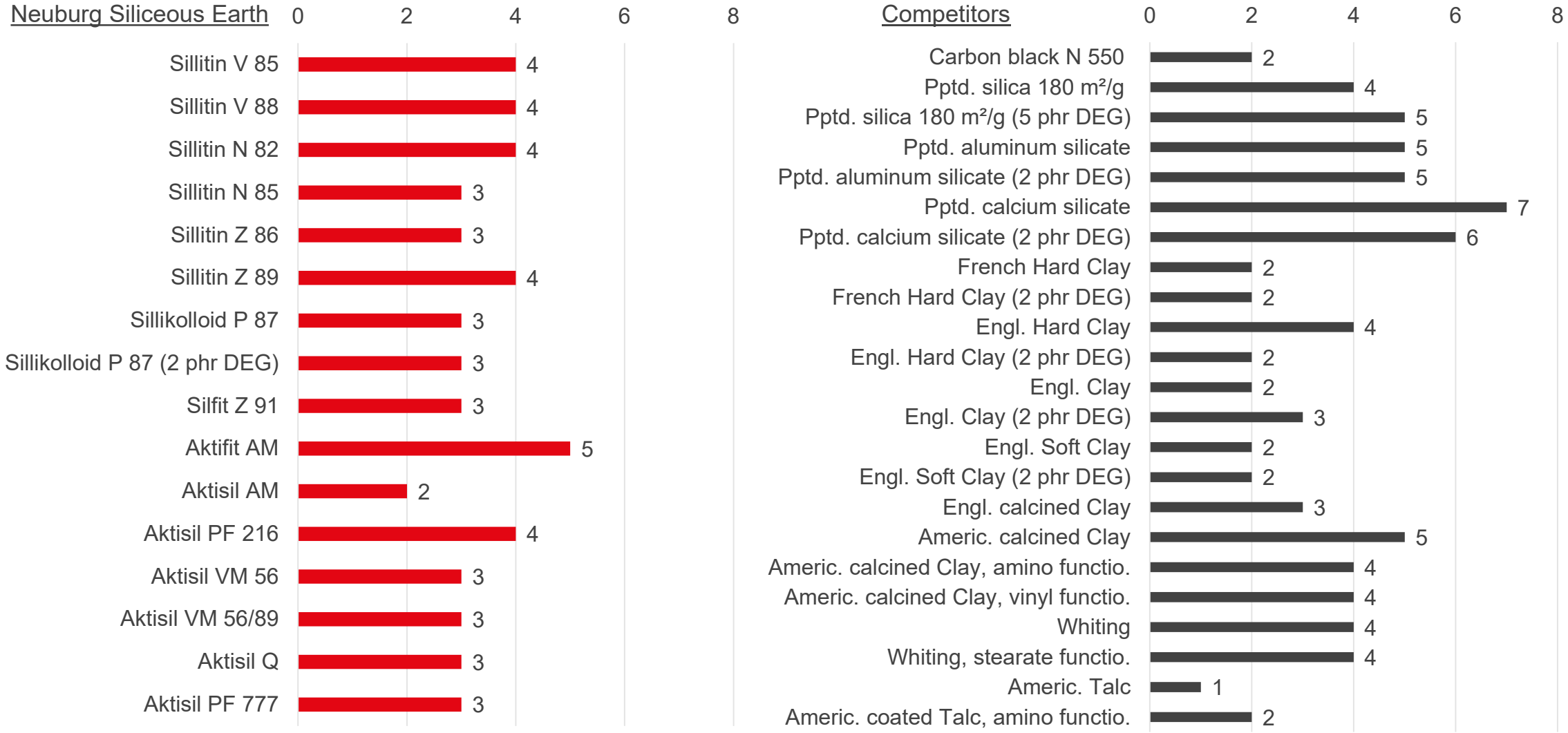
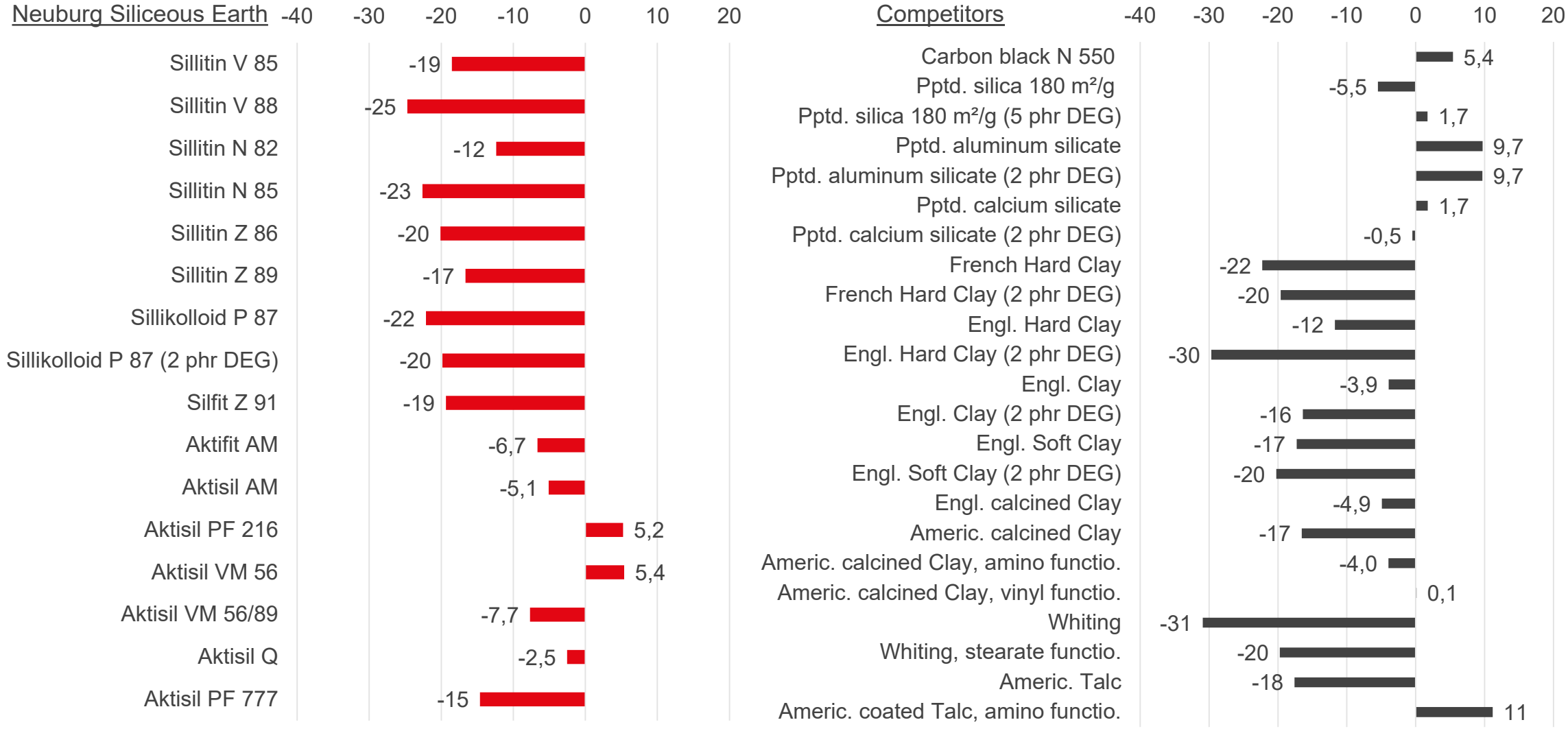
# Hot air aging 168 h / 70 °C
# Change of hardness in Shore A – piled up S2 dumbbells






Note: Sillitin N 82 will be replaced by Sillitin N 75

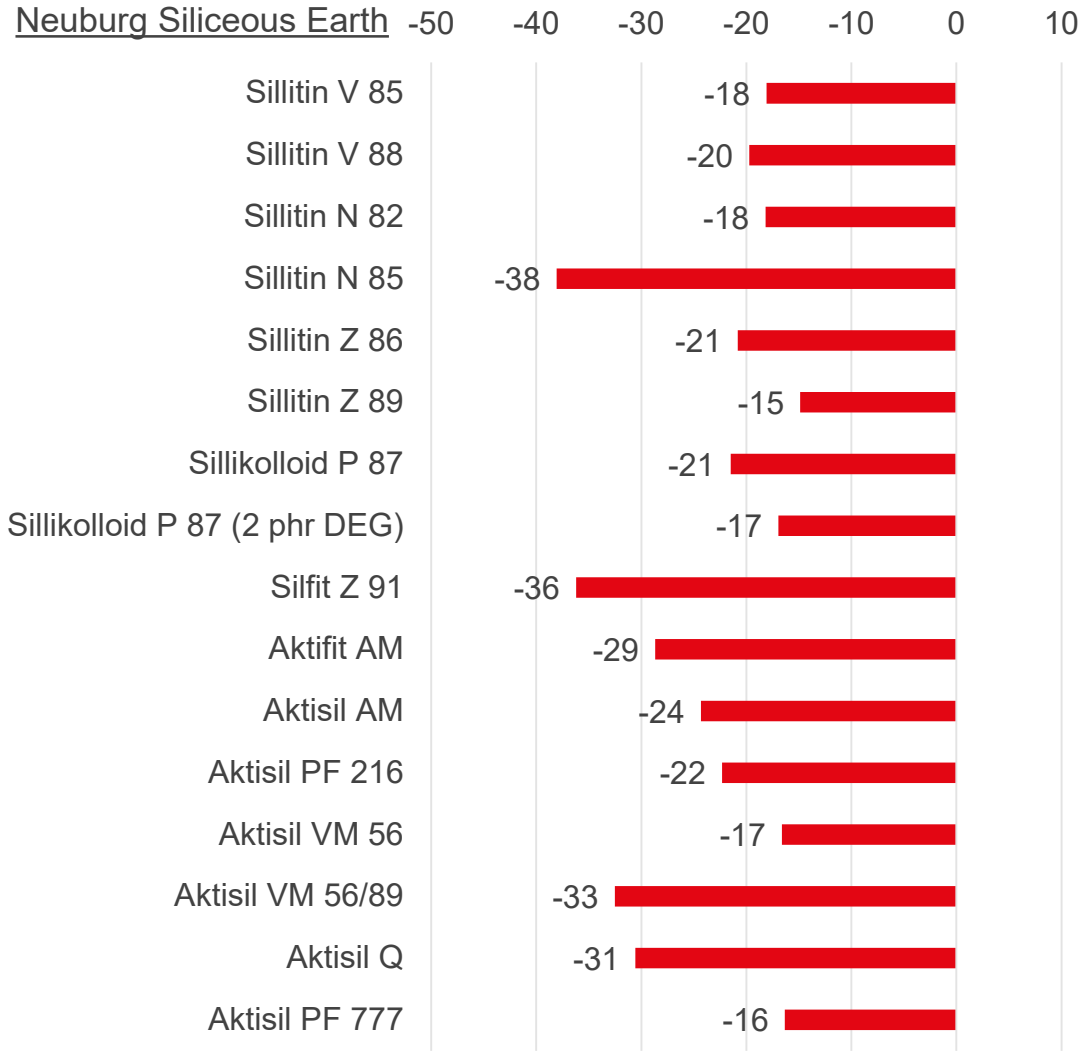
# Hot air aging 168 h / 70 °C
# Change of tensile strength in %

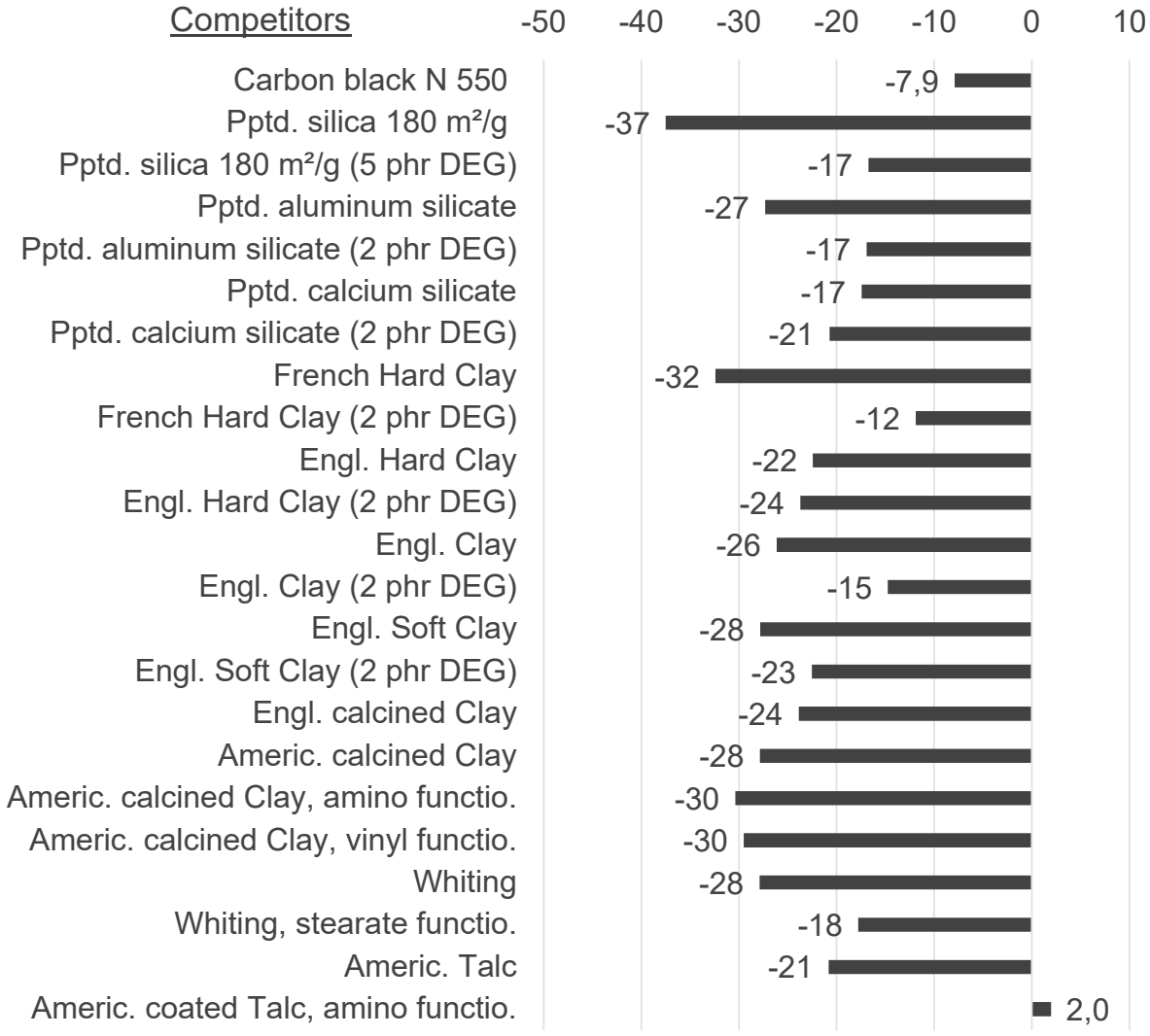





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Hot air aging 168 h / 70 °C
# Change of elongation at break in rel.%

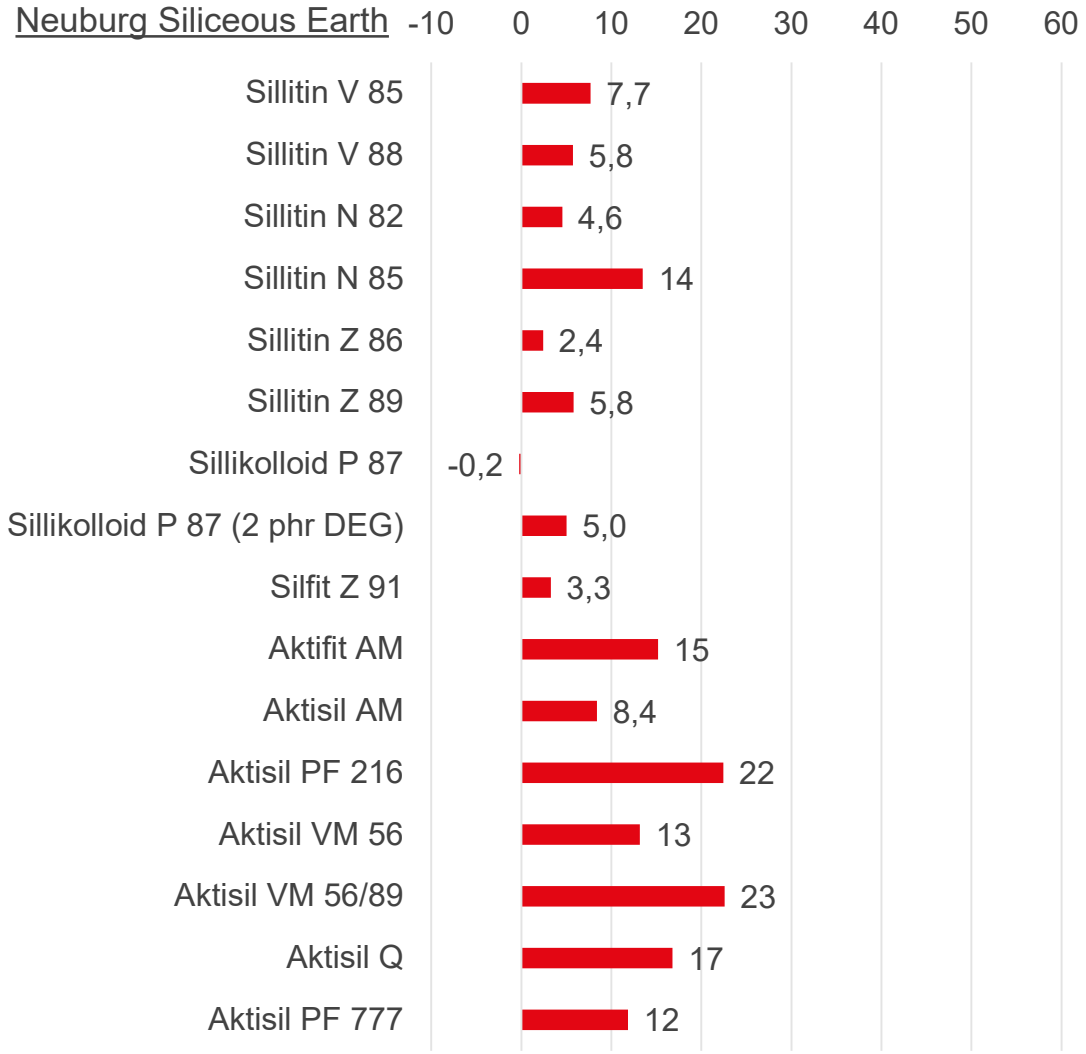


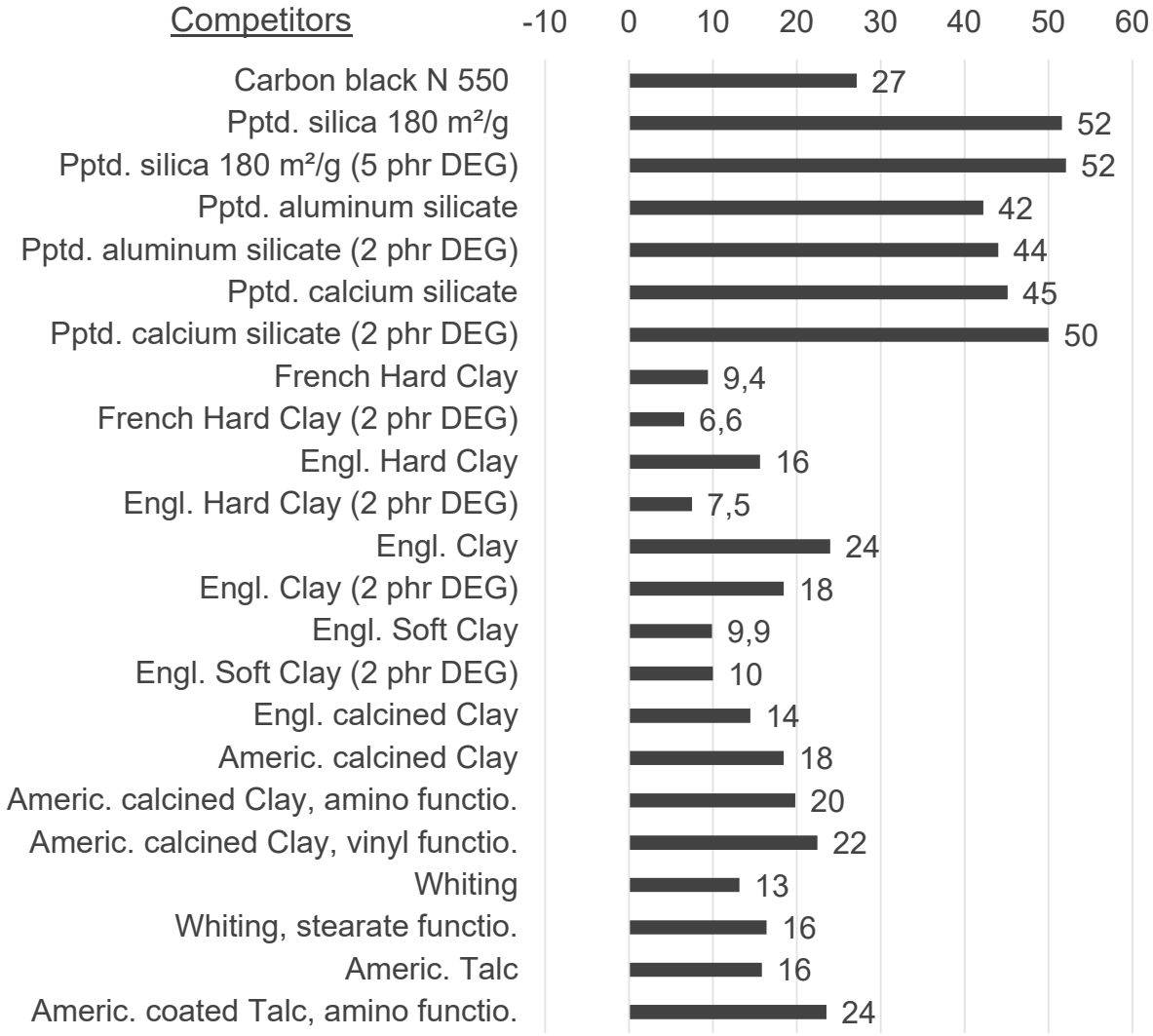





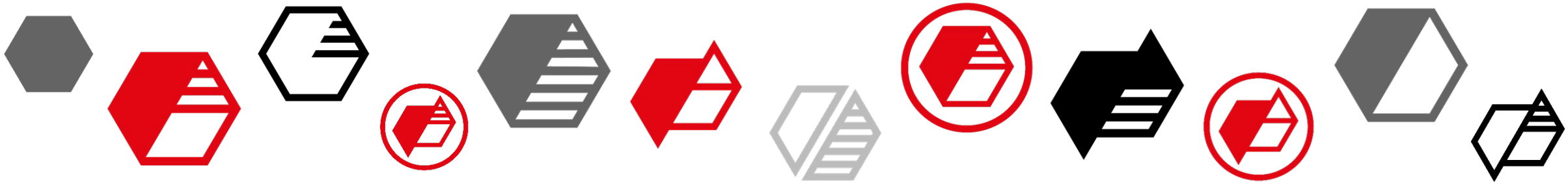

Note: Sillitin N 82 will be replaced by Sillitin N 75

# Hot air aging 168 h / 70 °C
# Change of modulus 100 % in %




Note: Sillitin N 82 will be replaced by Sillitin N 75



→ back to results

# Hot air aging 168 h / 100 °C

ISO 188, D

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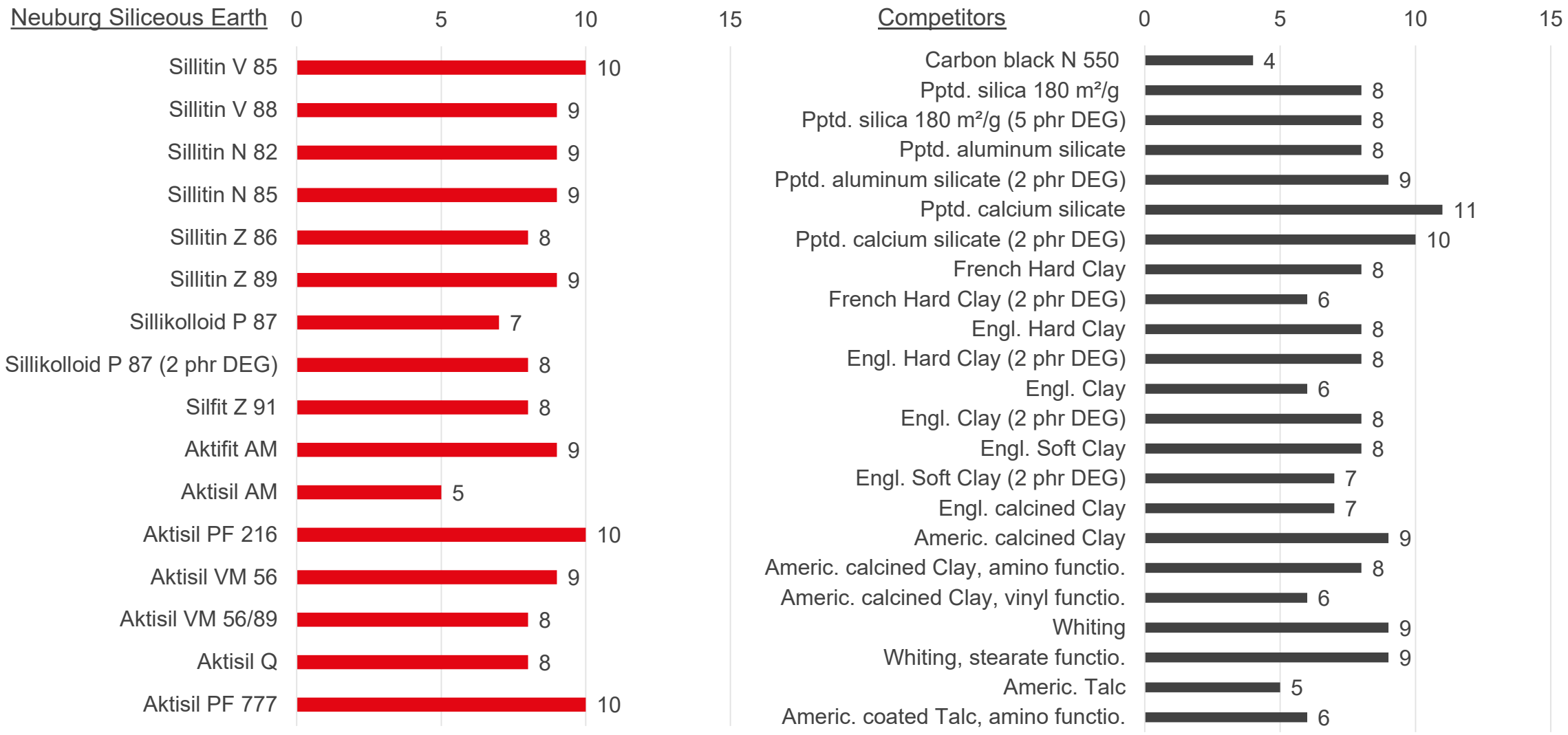
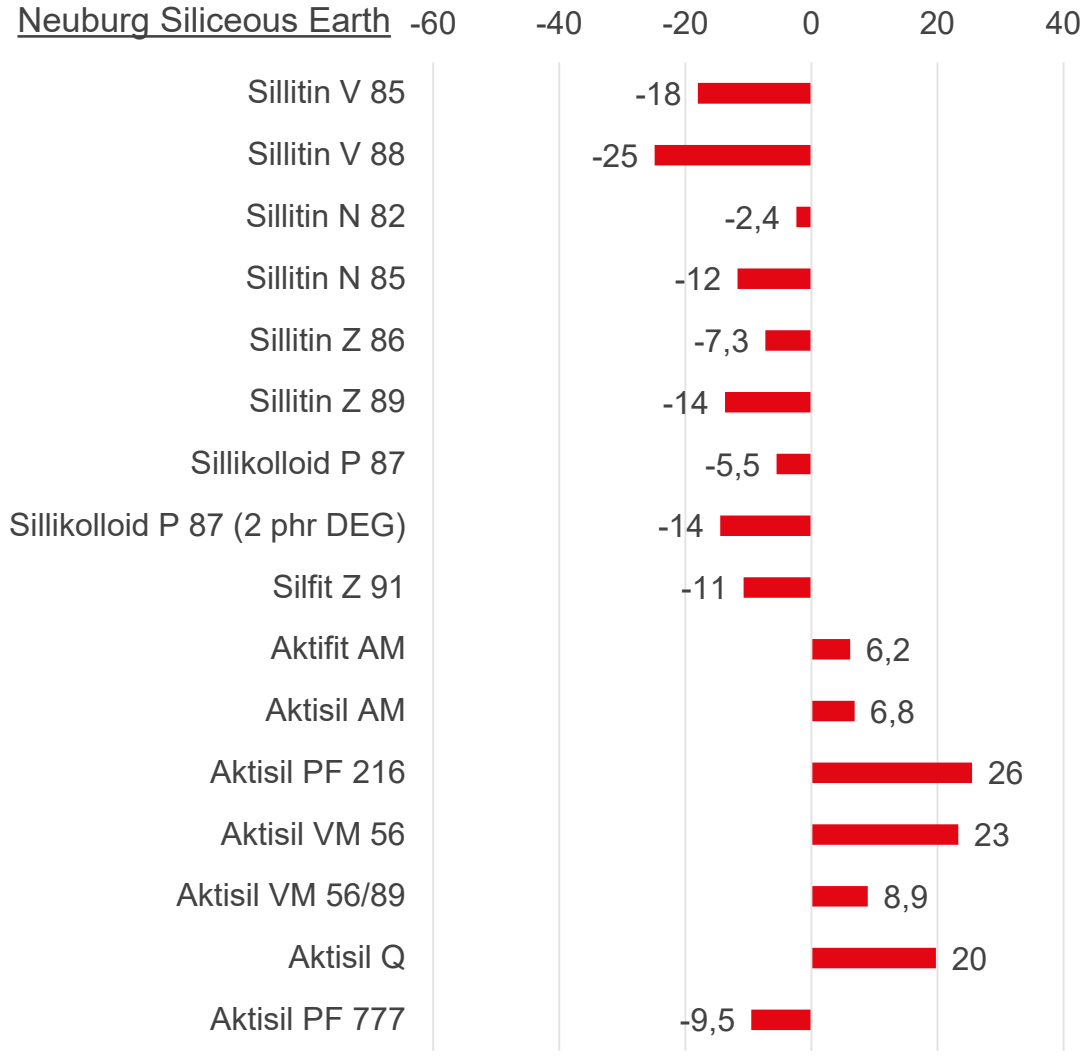
# Hot air aging 168 h / 100 °C
# Change of hardness in Shore A – piled up S2 dumbbells

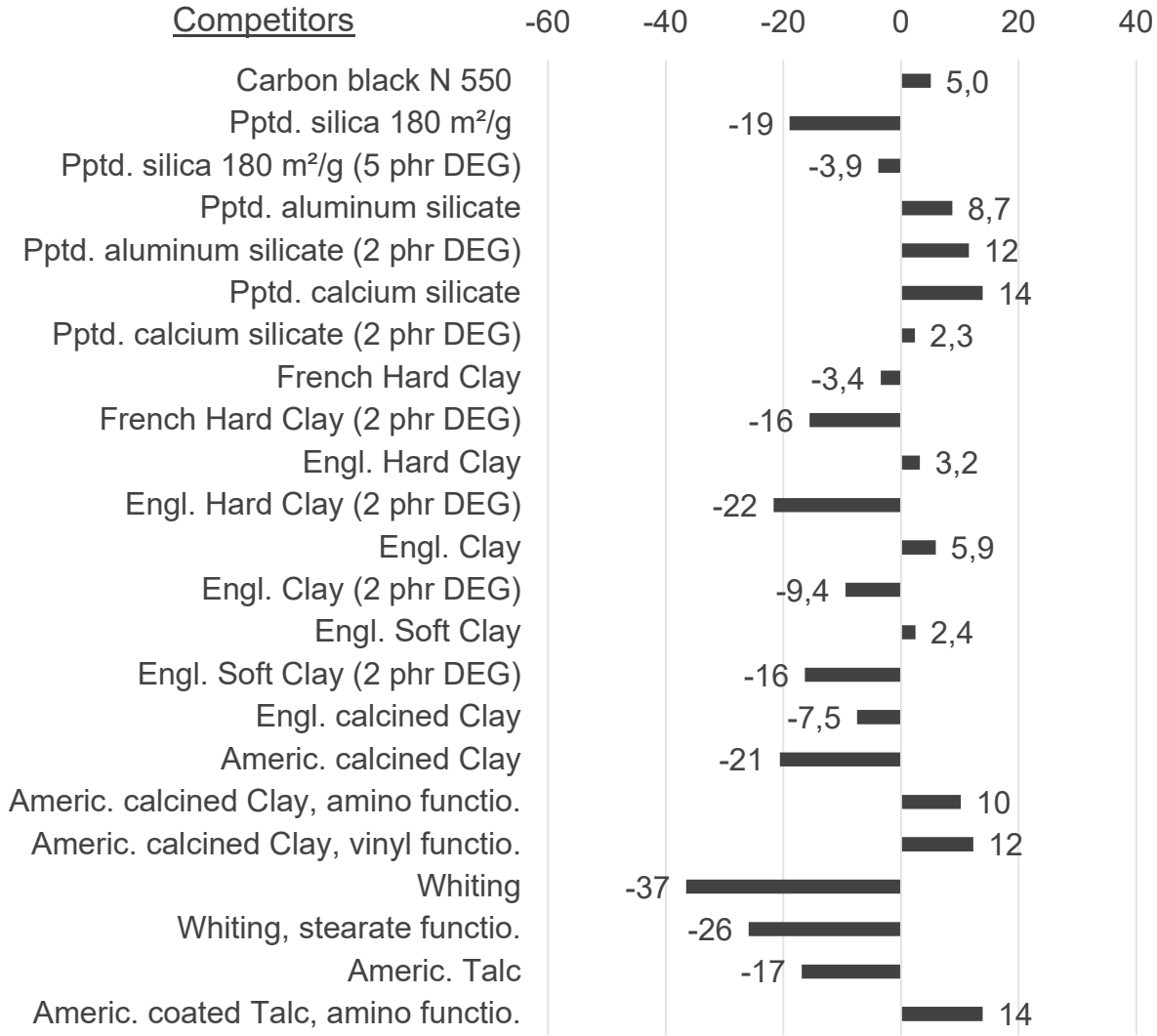





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Hot air aging 168 h / 100 °C
# Change of tensile strength in %

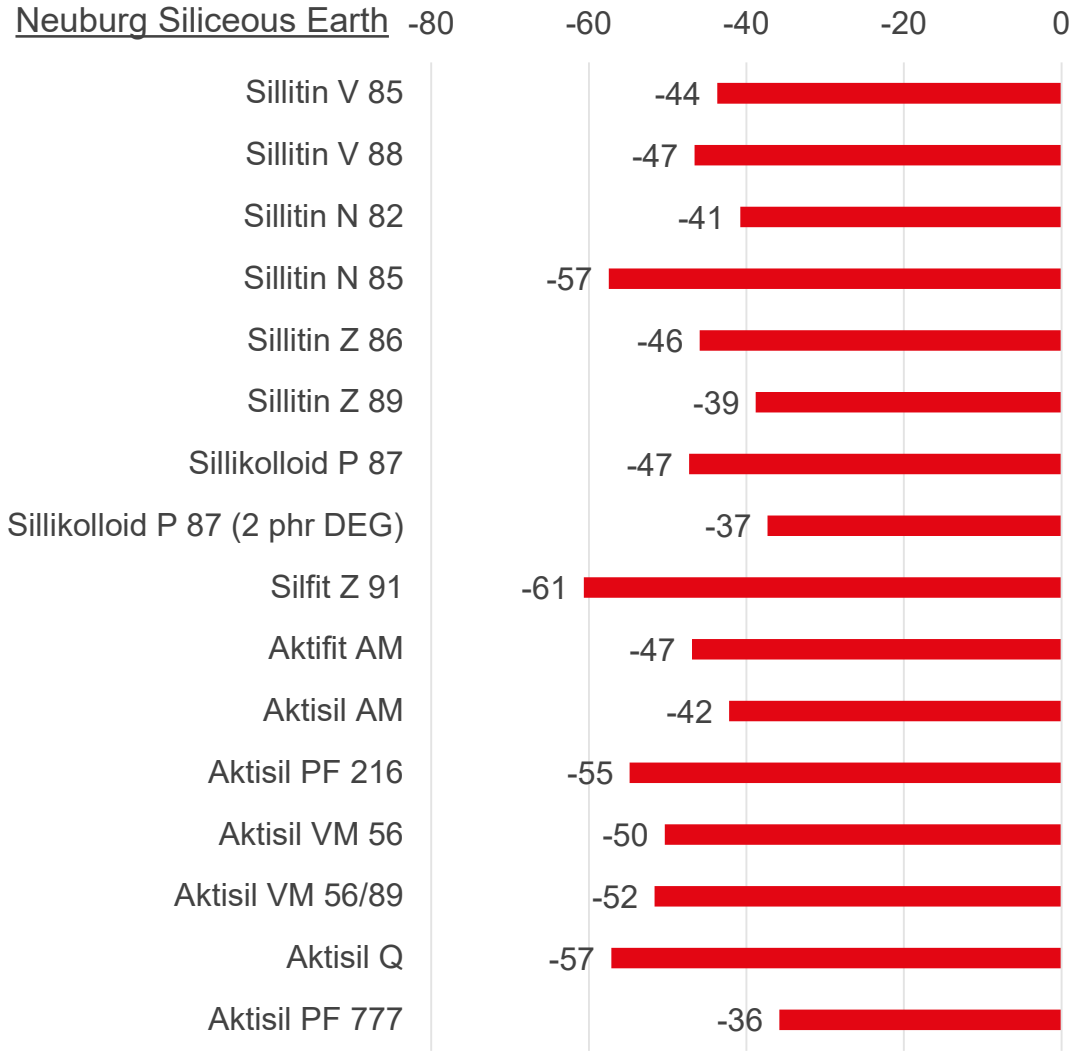


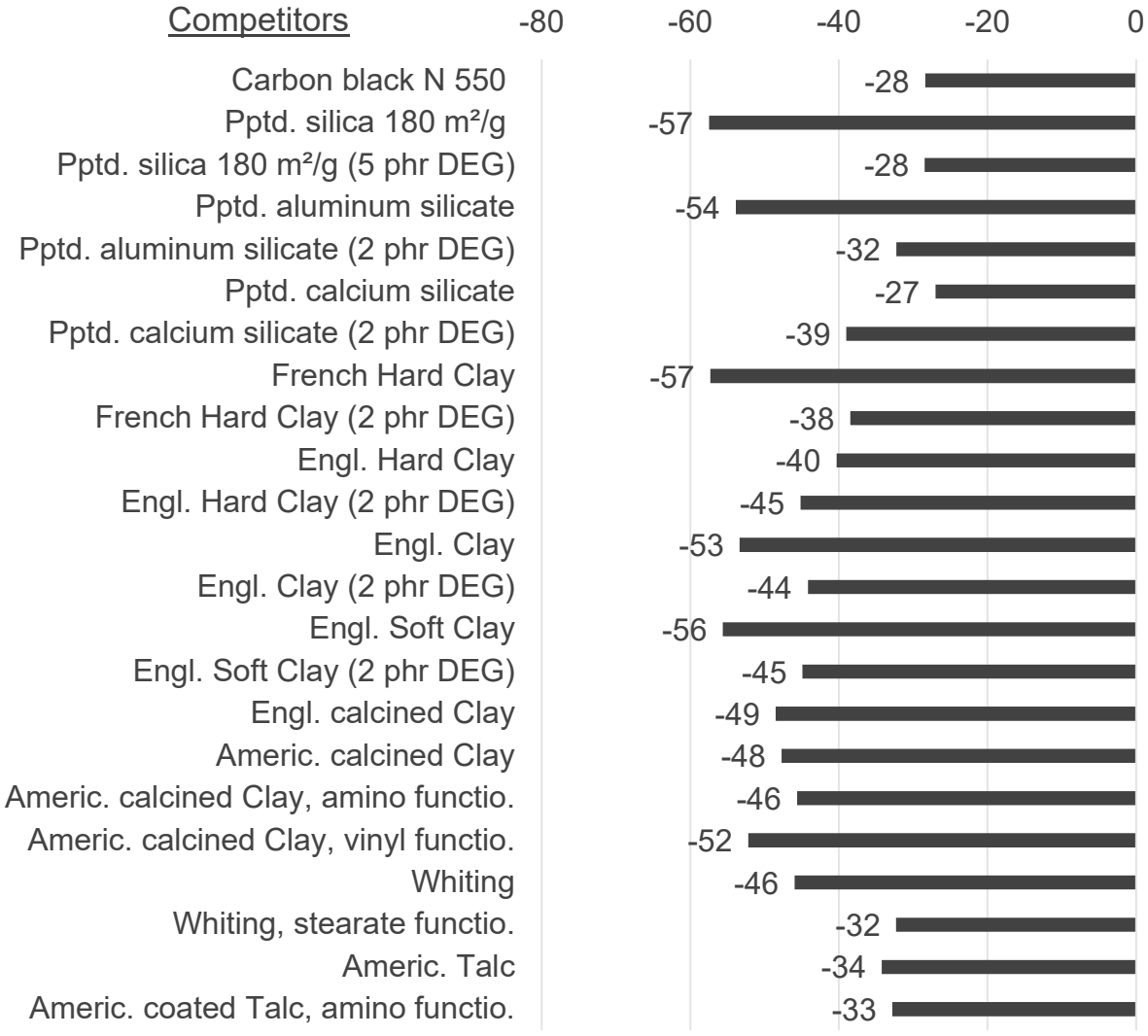






Note: Sillitin N 82 will be replaced by Sillitin N 75

# Hot air aging 168 h / 100 °C
# Change of elongation at break in rel.%

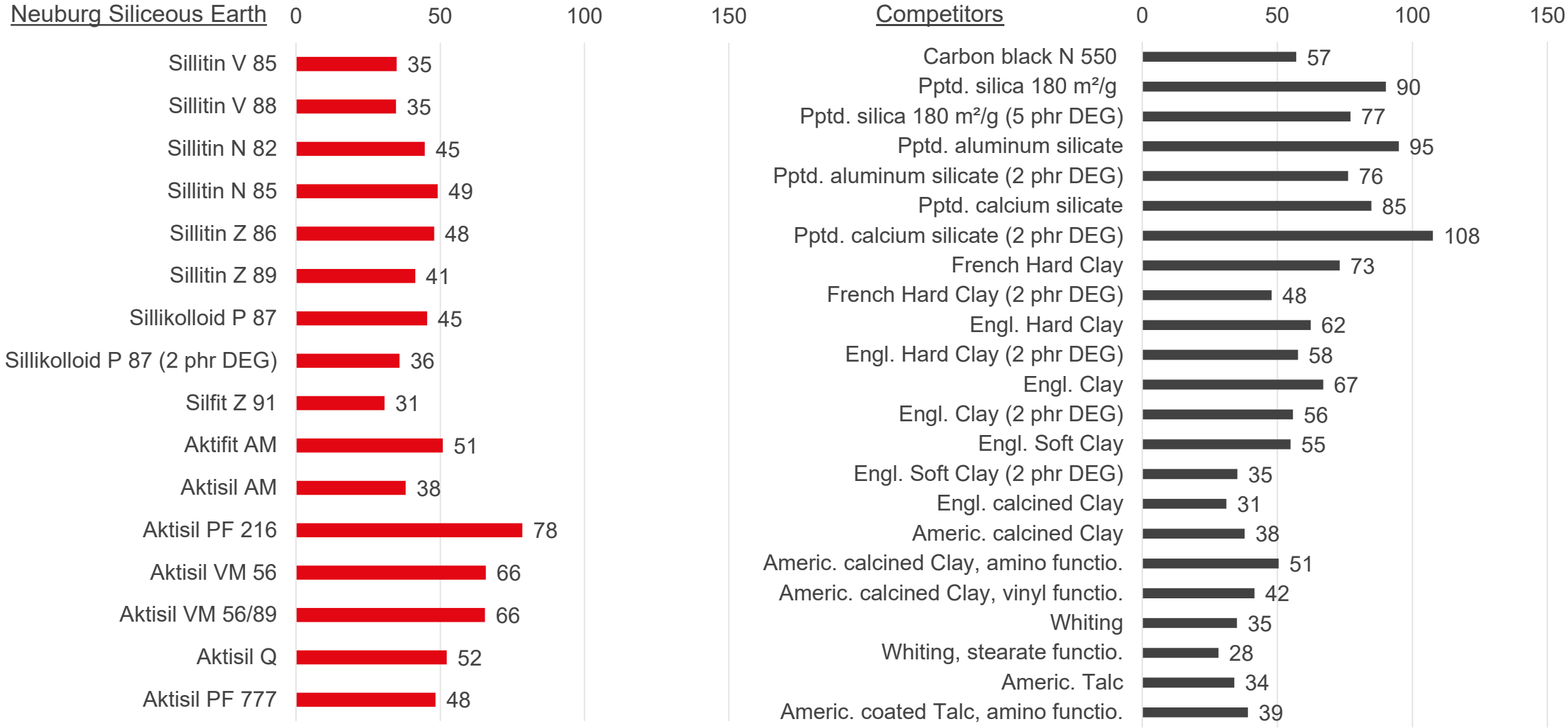


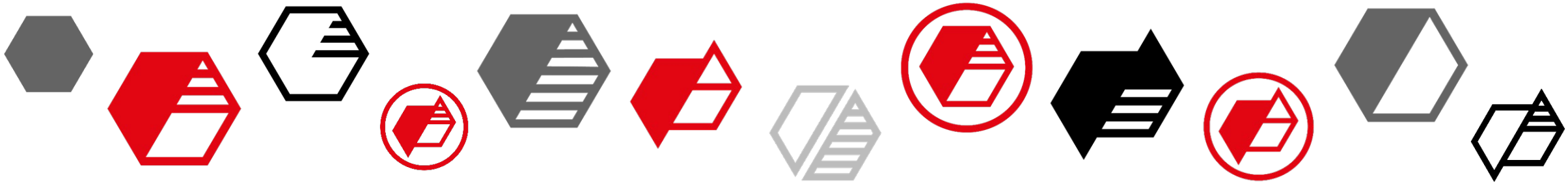



Note: Sillitin N 82 will be replaced by Sillitin N 75

# Hot air aging 168 h / 100 °C
# Change of modulus 100 % in %




Note: Sillitin N 82 will be replaced by Sillitin N 75



→ back to results

# Immersion in deionized water 168 h / 95 °C

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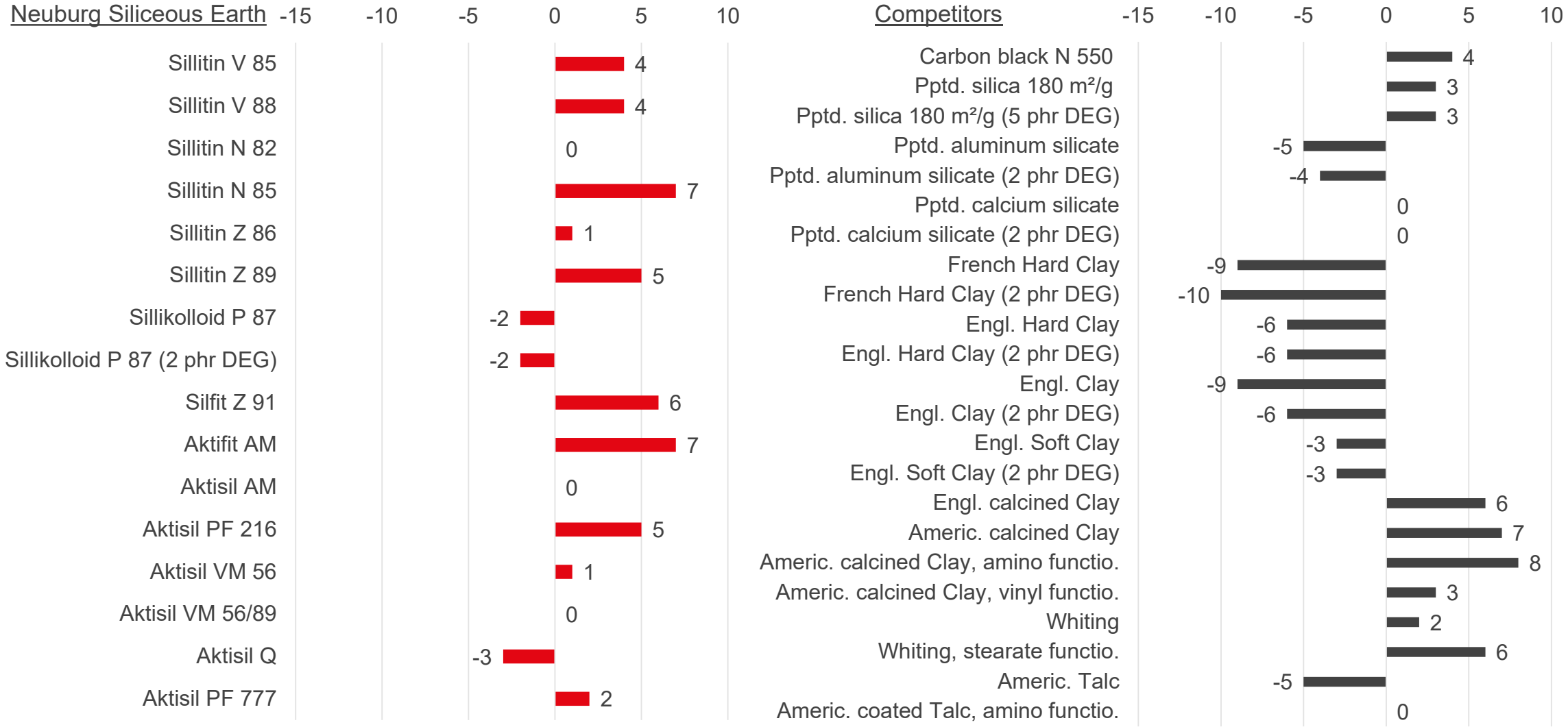
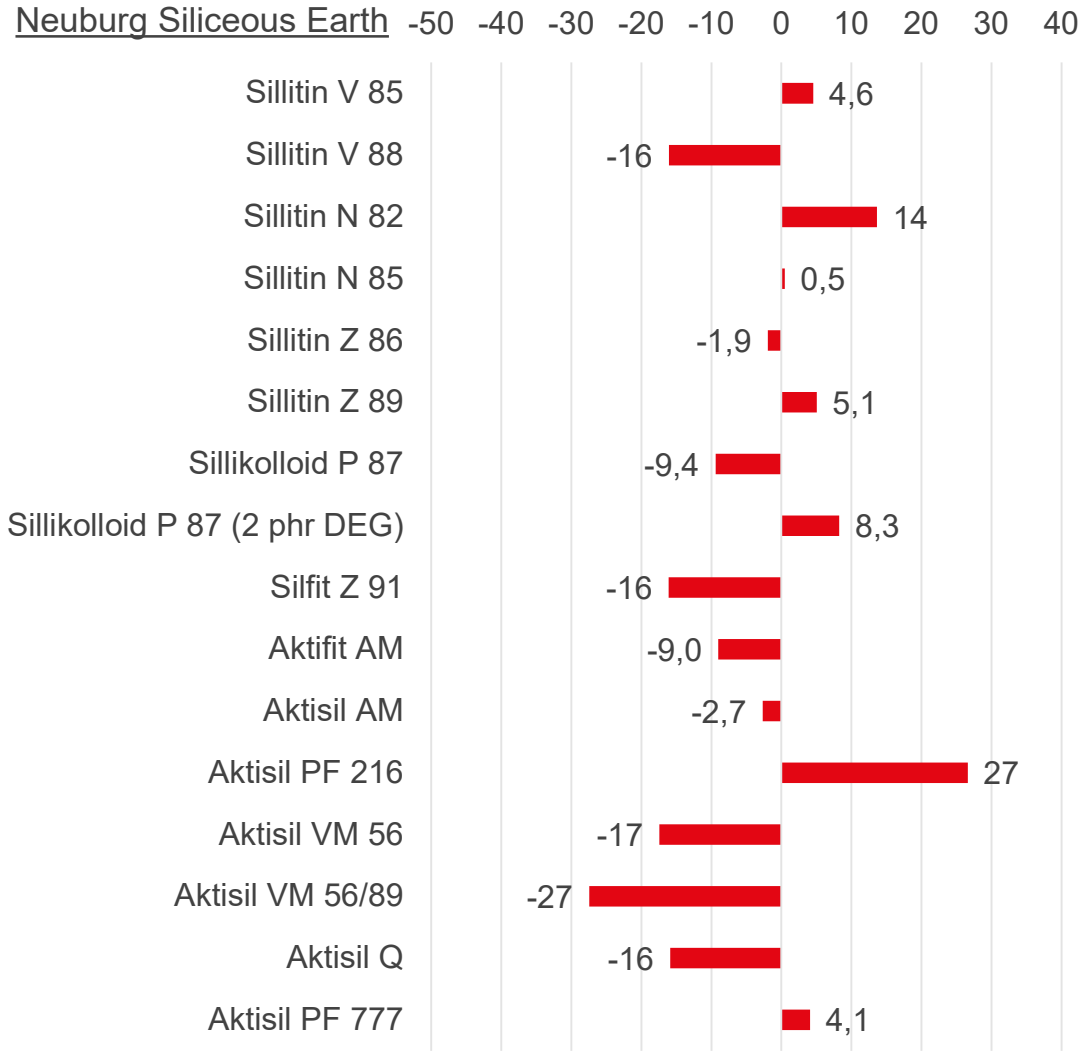
# Immersion in deionized water 168 h / 95 °C
# Change of hardness in Shore A – piled up S2 dumbbells

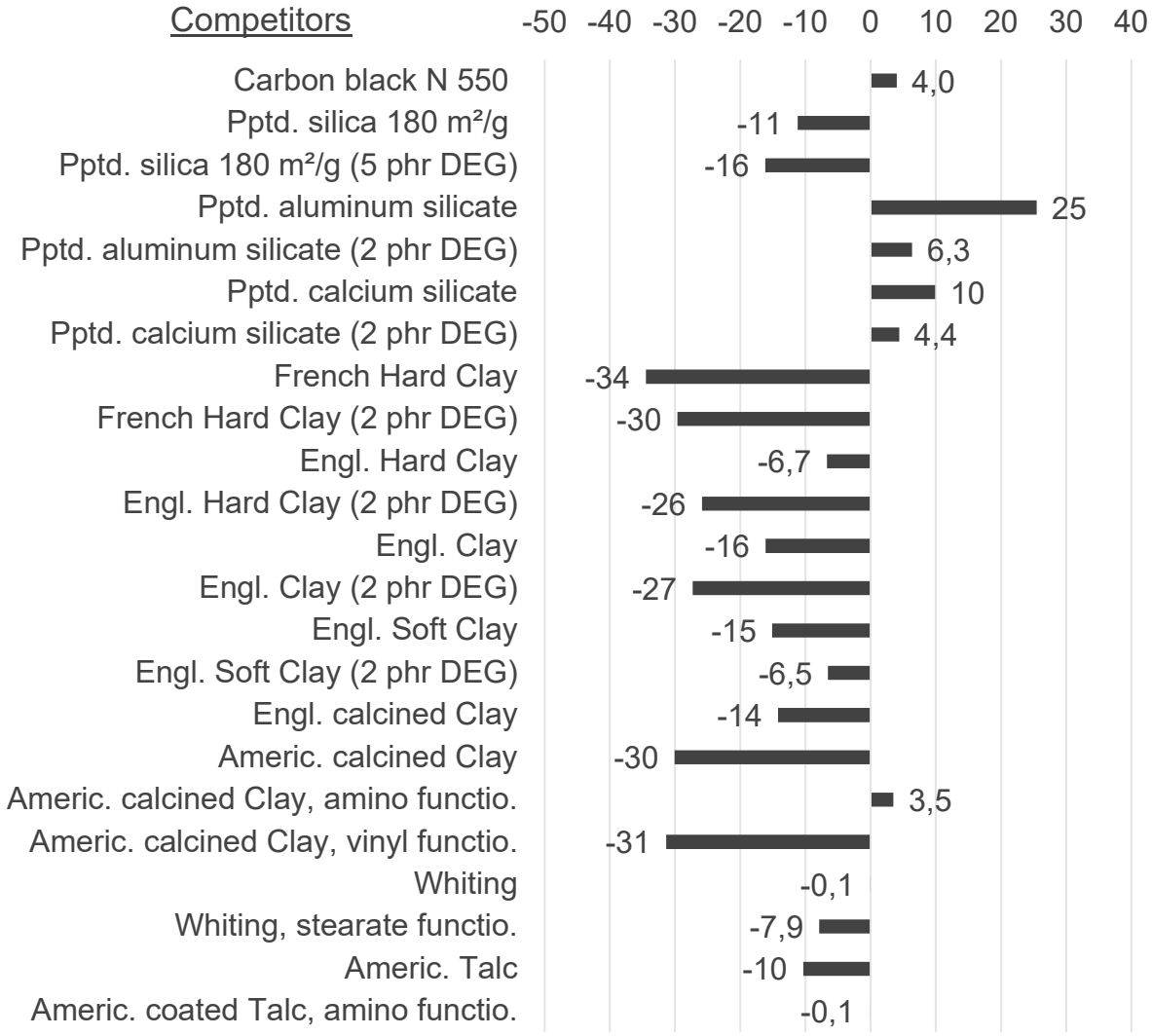





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Immersion in deionized water 168 h / 95 °C
# Change of tensile strength in %

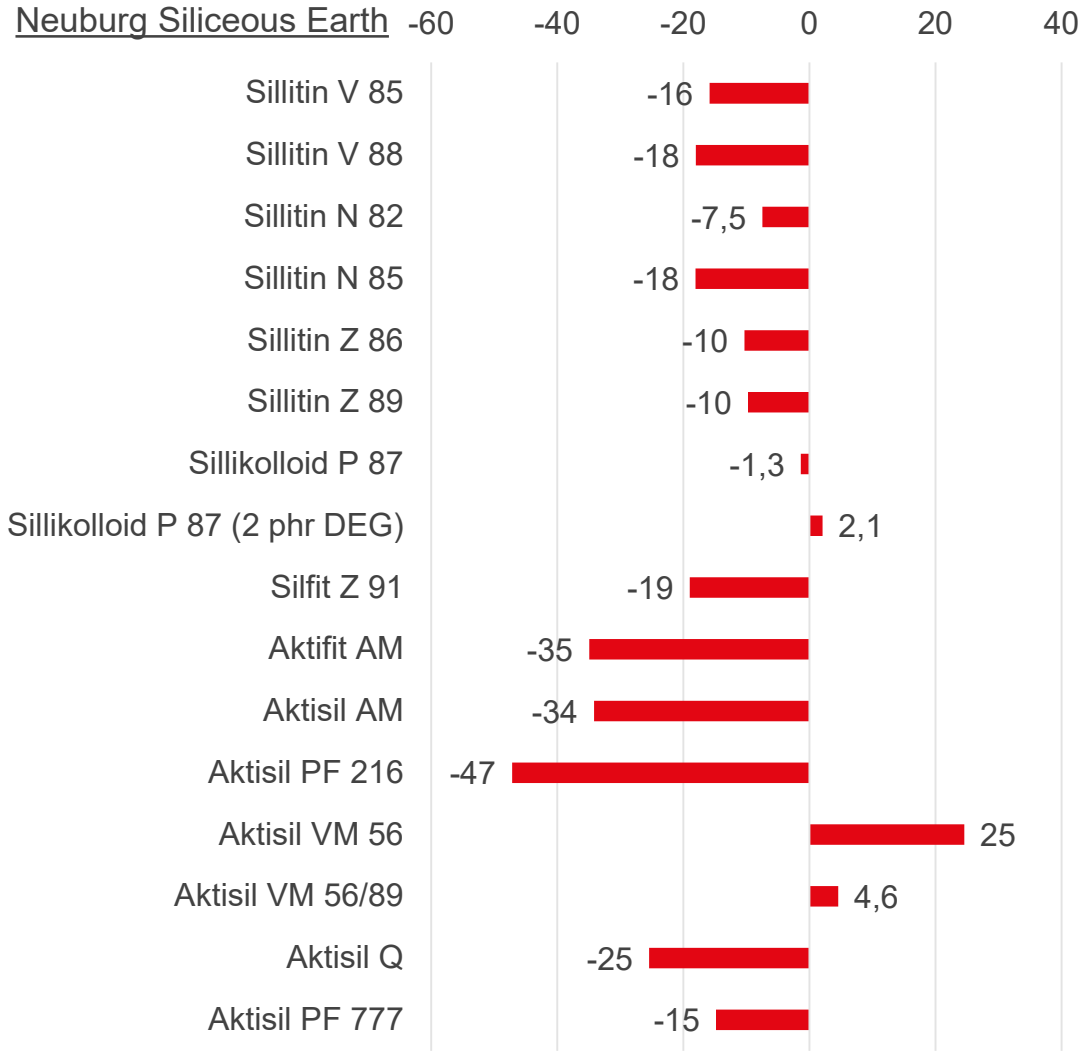


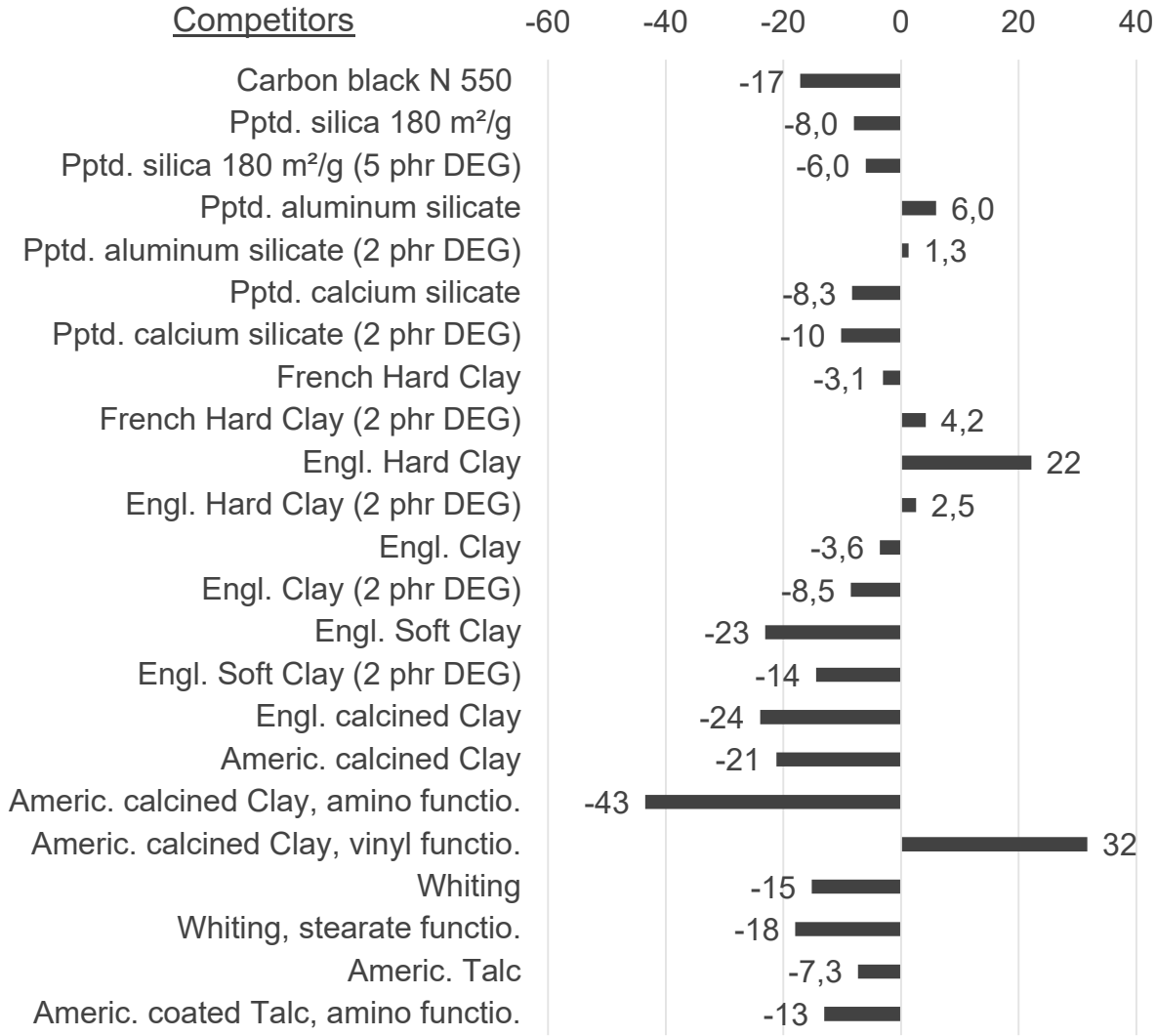






Note: Sillitin N 82 will be replaced by Sillitin N 75

# Immersion in deionized water 168 h / 95 °C
# Change of elongation at break in rel.%

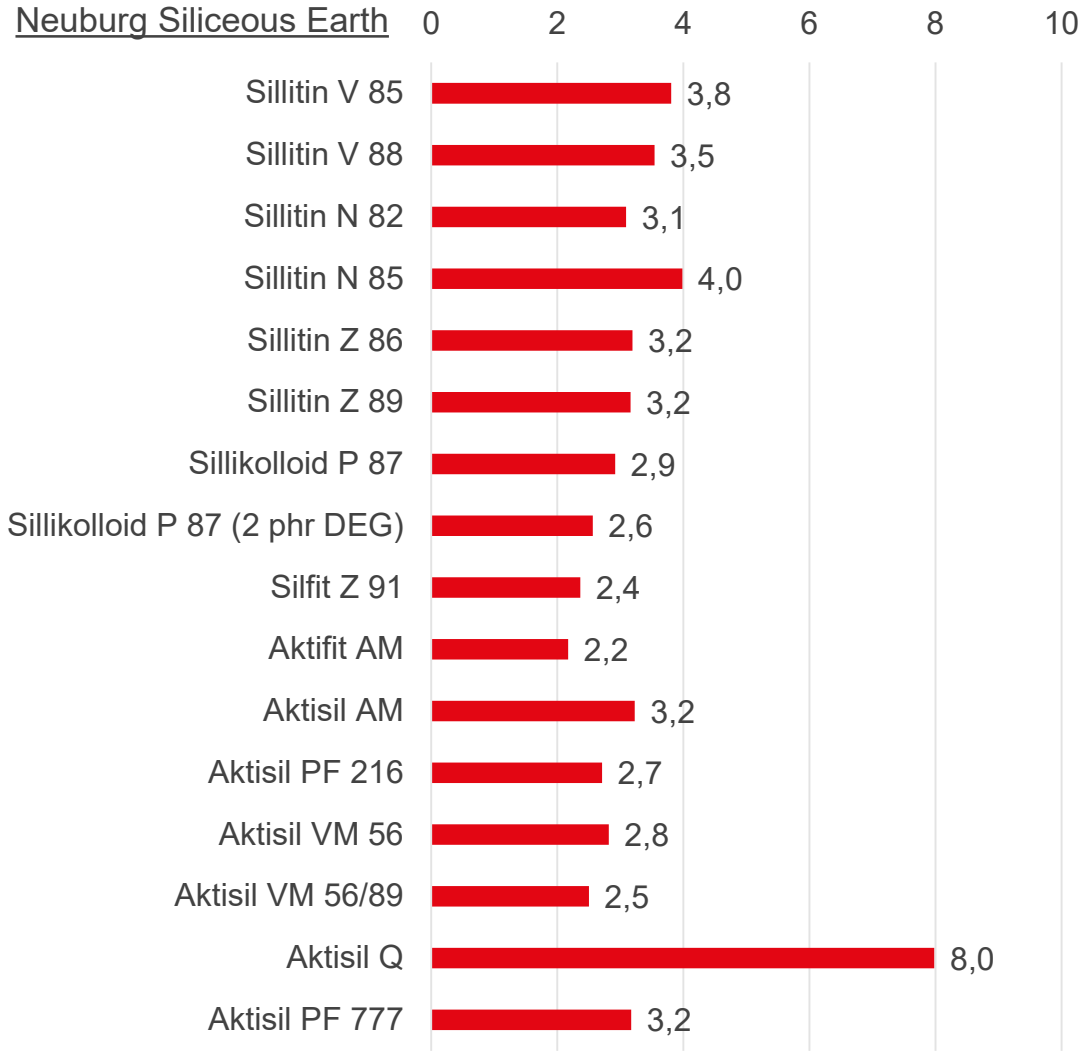


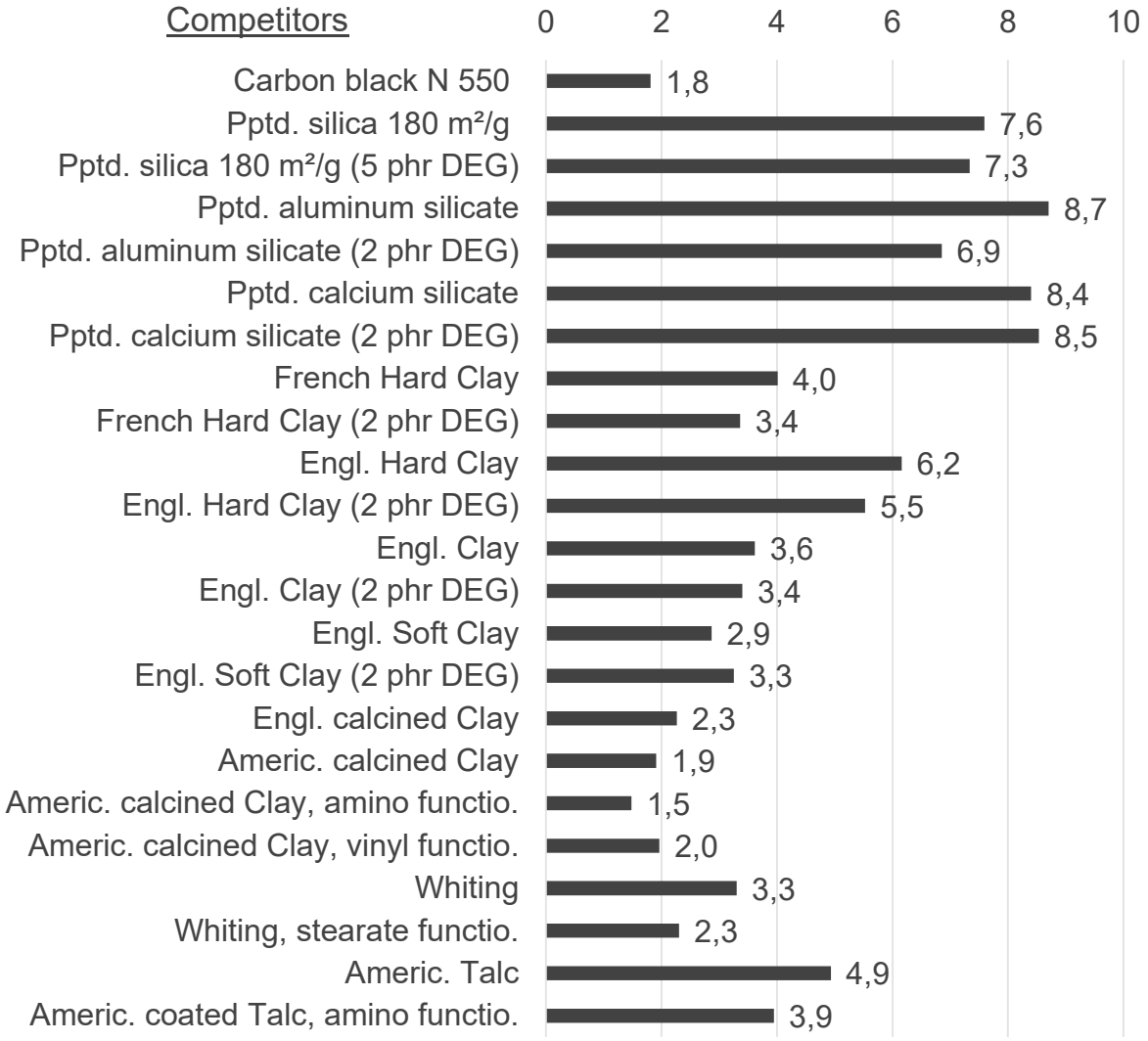






Note: Sillitin N 82 will be replaced by Sillitin N 75

# Immersion in deionized water 168 h / 95 °C
# Change of weight in %

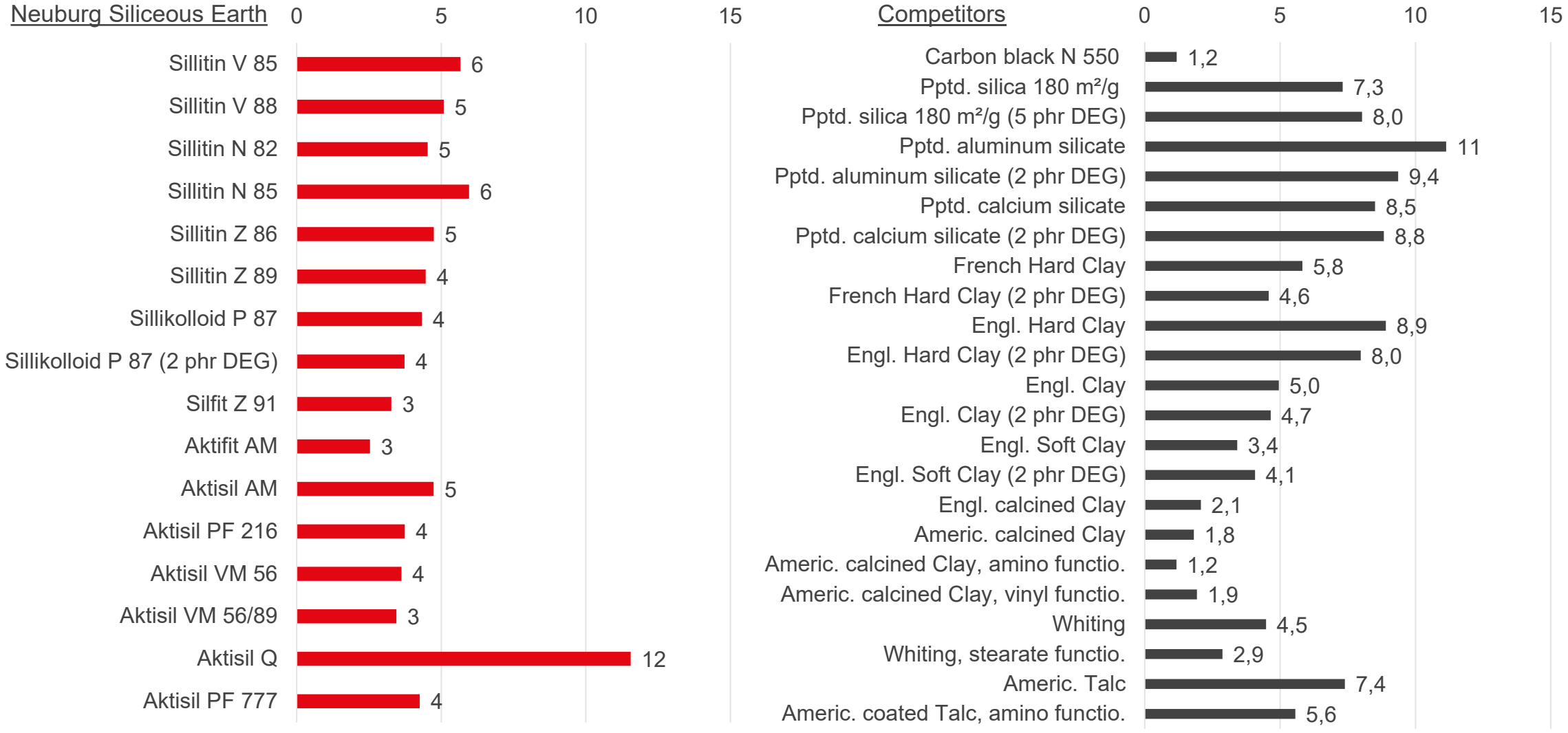





Note: Sillitin N 82 will be replaced by Sillitin N 75

# Immersion in deionized water 168 h / 95 °C
# Change of volume in %






Note: Sillitin N 82 will be replaced by Sillitin N 75

# **Summary:** Special features…

... of Neuburg Siliceous Earth in peroxide-cured EPDM rubber for extrusion applications (Sillitin, Aktisil, Silfit, Aktifit)

**Characteristic for Neuburg Siliceous Earth:**
- good processing properties with medium viscosity
- often long scorch times with a frequently fast cure time

**Compression set:**
- good performance with functionalized Neuburg Siliceous Earth fillers, best performance with Aktisil AM and Aktifit AM
- compared to Sillikolloid P 87 without DEG the DEG addition to reduces the compression set

**Tensile test results after vulcanization:**
- good results in tensile strength and modulus 100 % with Aktisil AM, Aktisil PF 216 and Aktifit AM
- high tear resistance with Aktisil VM 56, Aktisil VM 56/89 and Sillikolloid P 87

**Hot air aging (168 h / 70 °C; 100 °C):**
overall, the best performance is achievable with Aktisil AM

**Immersion in deionized water (168 h / 95 °C):**
good water resistance with almost all NSE products with very low weight and volume increase

# We supply materials for good ideas!

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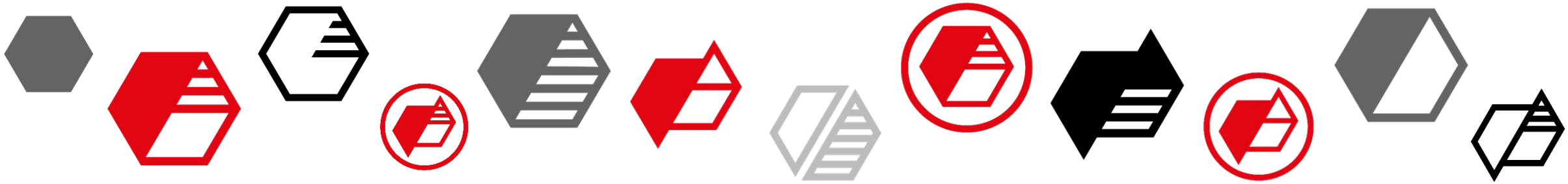

→ back to results

# Results in tabular form

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# Properties of raw compound – Mooney Viscosity and Scorch

| Neuburg Siliceous Earth | Mooney Viscosity ML 1+4 (100 °C) [MU] | Mooney Scorch ML +5 (120 °C) [min.] |
|---|---|---|
| Sillitin V 85 | 90 | 27 |
| Sillitin V 88 | 83 | 26 |
| Sillitin N 82 | 93 | 24 |
| Sillitin N 85 | 91 | 29 |
| Sillitin Z 86 | 99 | 24 |
| Sillitin Z 89 | 87 | 27 |
| Sillikolloid P 87 | 106 | 23 |
| Sillikolloid P 87 (2 phr DEG) | 105 | 17 |
| Silfit Z 91 | 94 | 26 |
| Aktifit AM | 98 | 7 |
| Aktisil AM | 86 | 10 |
| Aktisil PF 216 | 89 | 14 |
| Aktisil VM 56 | 82 | 20 |
| Aktisil VM 56/89 | 83 | 22 |
| Aktisil Q | 73 | 23 |
| Aktisil PF 777 | 69 | 14 |

| Competitors | Mooney Viscosity ML 1+4 (100 °C) [MU] | Mooney Scorch ML +5 (120 °C) [min.] |
|---|---|---|
| Carbon black N 550 | 90 | 10 |
| Pptd. silica 180 m²/g | 158 | 22 |
| Pptd. silica 180 m²/g (5 phr DEG) | 112 | 19 |
| Pptd. aluminum silicate | 116 | 15 |
| Pptd. aluminum silicate (2 phr DEG) | 107 | 13 |
| Pptd. calcium silicate | 98 | 14 |
| Pptd. calcium silicate (2 phr DEG) | 95 | 12 |
| French Hard Clay | 82 | 27 |
| French Hard Clay (2 phr DEG) | 89 | 25 |
| Engl. Hard Clay | 88 | 42 |
| Engl. Hard Clay (2 phr DEG) | 93 | 28 |
| Engl. Clay | 66 | 19 |
| Engl. Clay (2 phr DEG) | 64 | 18 |
| Engl. Soft Clay | 53 | 22 |
| Engl. Soft Clay (2 phr DEG) | 53 | 14 |
| Engl. calcined Clay | 90 | 29 |
| Americ. calcined Clay | 81 | 29 |
| Americ. calcined Clay, amino functio. | 83 | 16 |
| Americ. calcined Clay, vinyl functio. | 81 | 27 |
| Whiting | 49 | 29 |
| Whiting, stearate functio. | 42 | 27 |
| Americ. Talc | 51 | 19 |
| Americ. coated Talc, amino functio. | 52 | 21 |

# Properties of raw compound – Neuburg Siliceous Earth

| Rotorless Curemeter 180 °C | Torque minimum [Nm] | Cross-linking yield [Nm] | Conversion time $t_5$ [min.] | Conversion time $t_{90}$ [min.] | Max. speed of vulcanization [Nm/min.] | Time until max. speed of vulcanization [min.] | tan δ |
|---|---|---|---|---|---|---|---|
| Sillitin V 85 | 0.16 | 0.56 | 0.75 | 4.57 | 0.39 | 1.42 | 0.13 |
| Sillitin V 88 | 0.13 | 0.53 | 0.78 | 3.64 | 0.43 | 1.59 | 0.12 |
| Sillitin N 82 | 0.21 | 0.62 | 0.68 | 6.20 | 0.41 | 1.25 | 0.15 |
| Sillitin N 85 | 0.18 | 0.58 | 0.75 | 5.26 | 0.39 | 1.39 | 0.14 |
| Sillitin Z 86 | 0.26 | 0.66 | 0.65 | 7.59 | 0.42 | 1.20 | 0.16 |
| Sillitin Z 89 | 0.18 | 0.57 | 0.82 | 4.74 | 0.44 | 1.43 | 0.14 |
| Sillikolloid P 87 | 0.31 | 0.74 | 0.27 | 10.30 | 0.39 | 1.06 | 0.19 |
| Sillikolloid P 87 (2 phr DEG) | 0.29 | 0.69 | 0.59 | 5.87 | 0.65 | 1.11 | 0.22 |
| Silfit Z 91 | 0.16 | 0.53 | 1.03 | 4.18 | 0.37 | 1.90 | 0.10 |
| Aktifit AM | 0.16 | 0.58 | 0.47 | 1.91 | 0.89 | 0.77 | 0.08 |
| Aktisil AM | 0.14 | 0.53 | 0.49 | 2.34 | 0.77 | 0.76 | 0.11 |
| Aktisil PF 216 | 0.15 | 0.67 | 0.52 | 5.79 | 0.35 | 1.04 | 0.11 |
| Aktisil VM 56 | 0.14 | 0.51 | 0.66 | 6.16 | 0.32 | 1.24 | 0.15 |
| Aktisil VM 56/89 | 0.14 | 0.52 | 0.70 | 5.41 | 0.36 | 1.33 | 0.14 |
| Aktisil Q | 0.09 | 0.53 | 0.87 | 4.27 | 0.39 | 1.93 | 0.10 |
| Aktisil PF 777 | 0.08 | 0.41 | 0.64 | 5.55 | 0.25 | 1.32 | 0.11 |

# Properties of raw compound – Competitors

| Rotorless Curemeter 180 °C | Torque minimum [Nm] | Cross-linking yield [Nm] | Conversion time $t_5$ [min.] | Conversion time $t_{90}$ [min.] | Max. speed of vulcanization [Nm/min.] | Time until max. speed of vulcanization [min.] | tan δ |
|---|---|---|---|---|---|---|---|
| Carbon black N 550 | 0.16 | 0.65 | 0.42 | 2.77 | 0.72 | 0.93 | 0.18 |
| Pptd. silica 180 m²/g | 0.60 | 1.10 | 0.25 | 13.13 | 0.68 | 0.34 | 0.11 |
| Pptd. silica 180 m²/g (5 phr DEG) | 0.44 | 1.53 | 0.36 | 14.67 | 0.61 | 1.31 | 0.07 |
| Pptd. aluminum silicate | 0.37 | 1.34 | 0.32 | 8.34 | 0.81 | 0.73 | 0.13 |
| Pptd. aluminum silicate (2 phr DEG) | 0.30 | 1.53 | 0.27 | 6.61 | 1.14 | 0.78 | 0.10 |
| Pptd. calcium silicate | 0.26 | 1.19 | 0.24 | 4.19 | 1.09 | 0.87 | 0.09 |
| Pptd. calcium silicate (2 phr DEG) | 0.27 | 1.20 | 0.31 | 3.87 | 1.29 | 0.86 | 0.10 |
| French Hard Clay | 0.20 | 0.62 | 0.25 | 13.28 | 0.26 | 0.26 | 0.26 |
| French Hard Clay (2 phr DEG) | 0.27 | 0.73 | 0.23 | 10.50 | 0.45 | 1.15 | 0.28 |
| Engl. Hard Clay | 0.22 | 0.65 | 0.23 | 15.86 | 0.37 | 0.29 | 0.28 |
| Engl. Hard Clay (2 phr DEG) | 0.29 | 0.77 | 0.19 | 12.08 | 0.43 | 0.26 | 0.27 |
| Engl. Clay | 0.13 | 0.52 | 0.47 | 10.58 | 0.28 | 0.93 | 0.19 |
| Engl. Clay (2 phr DEG) | 0.15 | 0.61 | 0.54 | 8.96 | 0.43 | 1.01 | 0.23 |
| Engl. Soft Clay | 0.09 | 0.48 | 0.68 | 5.89 | 0.34 | 1.11 | 0.15 |
| Engl. Soft Clay (2 phr DEG) | 0.09 | 0.49 | 0.69 | 3.78 | 0.49 | 1.13 | 0.16 |
| Engl. calcined Clay | 0.19 | 0.59 | 1.26 | 5.64 | 0.38 | 2.10 | 0.12 |
| Americ. calcined Clay | 0.14 | 0.51 | 1.21 | 5.58 | 0.31 | 2.04 | 0.12 |
| Americ. calcined Clay, amino functio. | 0.12 | 0.49 | 0.74 | 2.88 | 0.54 | 1.19 | 0.08 |
| Americ. calcined Clay, vinyl functio. | 0.12 | 0.50 | 1.08 | 4.62 | 0.41 | 1.69 | 0.11 |
| Whiting | 0.06 | 0.40 | 0.74 | 5.47 | 0.22 | 1.63 | 0.10 |
| Whiting, stearate functio. | 0.04 | 0.32 | 0.88 | 4.23 | 0.23 | 1.88 | 0.10 |
| Americ. Talc | 0.08 | 0.49 | 0.63 | 8.86 | 0.26 | 1.40 | 0.20 |
| Americ. coated Talc, amino functio. | 0.07 | 0.49 | 0.65 | 5.67 | 0.36 | 1.25 | 0.15 |

# Properties of vulcanizate – Neuburg Siliceous Earth

| | Hardness S2 specimen [Shore A] | Tensile strength [MPa] | Elongation at break [%] | Modulus 100 % [MPa] | Tear resistance Trousers specimen [N/mm] | Rebound elasticity [%] | CS 70 °C (24 h / 25 % Def.) [%] | CS 100 °C (24 h / 25 % Def.) [%] |
|---|---|---|---|---|---|---|---|---|
| Sillitin V 85 | 61 | 4.4 | 654 | 2.3 | 9.7 | 44 | 21.2 | 58.7 |
| Sillitin V 88 | 60 | 4.0 | 623 | 2.1 | 8.2 | 44 | 19.9 | 53.1 |
| Sillitin N 82 | 63 | 4.9 | 642 | 2.7 | 12.6 | 43 | 23.8 | 55.7 |
| Sillitin N 85 | 63 | 4.6 | 662 | 2.5 | 11.3 | 44 | 21.9 | 58.1 |
| Sillitin Z 86 | 64 | 5.4 | 631 | 2.8 | 12.5 | 41 | 23.7 | 57.2 |
| Sillitin Z 89 | 61 | 4.7 | 634 | 2.4 | 11.3 | 42 | 23.5 | 57.8 |
| Sillikolloid P 87 | 65 | 6.1 | 598 | 3.2 | 15.3 | 39 | 26.4 | 57.7 |
| Sillikolloid P 87 (2 phr DEG) | 65 | 5.5 | 546 | 2.8 | 12.6 | 36 | 24.0 | 47.1 |
| Silfit Z 91 | 64 | 4.4 | 600 | 2.9 | 9.8 | 43 | 19.1 | 52.4 |
| Aktifit AM | 67 | 8.4 | 254 | 5.2 | 6.8 | 40 | 13.8 | 40.1 |
| Aktisil AM | 67 | 7.9 | 301 | 4.6 | 7.3 | 44 | 13.6 | 35.3 |
| Aktisil PF 216 | 70 | 8.0 | 275 | 5.2 | 6.4 | 42 | 17.0 | 56.0 |
| Aktisil VM 56 | 64 | 5.9 | 394 | 3.3 | 11.7 | 43 | 18.4 | 49.7 |
| Aktisil VM 56/89 | 65 | 6.8 | 483 | 3.2 | 11.9 | 41 | 18.4 | 51.0 |
| Aktisil Q | 64 | 4.2 | 493 | 2.9 | 7.3 | 45 | 15.3 | 44.9 |
| Aktisil PF 777 | 57 | 3.9 | 646 | 1.4 | 8.8 | 38 | 27.5 | 69.7 |

# Properties of vulcanizate – Competitors

| | Hardness S2 specimen [Shore A] | Tensile strength [MPa] | Elongation at break [%] | Modulus 100 % [MPa] | Tear resistance Trousers specimen [N/mm] | Rebound elasticity [%] | CS 70 °C (24 h / 25 % Def.) [%] | CS 100 °C (24 h / 25 % Def.) [%] |
|---|---|---|---|---|---|---|---|---|
| Carbon black N 550 | 70 | 14.9 | 311 | 5.6 | 6.1 | 36 | 13.0 | 36.8 |
| Pptd. silica 180 m²/g | 69 | 12.0 | 712 | 1.8 | 20.2 | 49 | 60.5 | 84.4 |
| Pptd. silica 180 m²/g (5 phr DEG) | 67 | 16.0 | 726 | 1.5 | 19.4 | 45 | 47.6 | 75.4 |
| Pptd. aluminum silicate | 64 | 6.6 | 670 | 1.4 | 16.3 | 49 | 51.0 | 79.9 |
| Pptd. aluminum silicate (2 phr DEG) | 63 | 8.7 | 723 | 1.5 | 16.9 | 46 | 51.2 | 81.7 |
| Pptd. calcium silicate | 61 | 5.8 | 717 | 1.6 | 13.0 | 47 | 43.4 | 76.6 |
| Pptd. calcium silicate (2 phr DEG) | 61 | 6.0 | 741 | 1.5 | 13.0 | 46 | 44.7 | 77.2 |
| French Hard Clay | 63 | 7.3 | 559 | 3.0 | 13.4 | 39 | 41.6 | 66.7 |
| French Hard Clay (2 phr DEG) | 67 | 7.9 | 539 | 3.2 | 12.6 | 35 | 35.0 | 56.9 |
| Engl. Hard Clay | 62 | 6.0 | 538 | 2.4 | 12.2 | 42 | 48.0 | 74.5 |
| Engl. Hard Clay (2 phr DEG) | 64 | 7.9 | 624 | 2.6 | 13.8 | 37 | 41.2 | 68.3 |
| Engl. Clay | 64 | 6.2 | 580 | 3.1 | 12.3 | 44 | 26.9 | 58.3 |
| Engl. Clay (2 phr DEG) | 63 | 6.3 | 571 | 2.8 | 10.8 | 40 | 27.0 | 49.1 |
| Engl. Soft Clay | 61 | 3.3 | 643 | 2.1 | 8.1 | 47 | 21.2 | 55.6 |
| Engl. Soft Clay (2 phr DEG) | 60 | 3.2 | 577 | 1.9 | 6.1 | 43 | 21.0 | 48.2 |
| Engl. calcined Clay | 64 | 3.2 | 551 | 2.2 | 6.9 | 39 | 22.5 | 49.0 |
| Americ. calcined Clay | 60 | 4.4 | 576 | 2.4 | 8.4 | 44 | 19.6 | 51.0 |
| Americ. calcined Clay, amino functio. | 64 | 7.8 | 263 | 4.8 | 5.7 | 46 | 13.5 | 43.2 |
| Americ. calcined Clay, vinyl functio. | 67 | 6.3 | 318 | 4.6 | 7.9 | 41 | 16.9 | 45.3 |
| Whiting | 48 | 2.9 | 635 | 1.1 | 5.1 | 48 | 22.1 | 62.6 |
| Whiting, stearate functio. | 42 | 2.2 | 574 | 0.7 | 3.1 | 43 | 27.0 | 60.3 |
| Americ. Talc | 64 | 6.9 | 579 | 3.2 | 9.3 | 44 | 30.2 | 53.3 |
| Americ. coated Talc, amino functio. | 66 | 7.5 | 202 | 5.9 | 5.4 | 46 | 21.7 | 48.0 |

# Hot air aging 168 h / 70 °C – Neuburg Siliceous Earth

| | Change of hardness S2 specimen [Shore A] | Change of tensile strength [%] | Change of elongation at break [rel.%] | Change of modulus 100 % [%] |
|---|---|---|---|---|
| Sillitin V 85 | 4 | -18.5 | -18.1 | 7.7 |
| Sillitin V 88 | 4 | -24.7 | -19.7 | 5.8 |
| Sillitin N 82 | 4 | -12.4 | -18.2 | 4.6 |
| Sillitin N 85 | 3 | -22.6 | -38.0 | 13.5 |
| Sillitin Z 86 | 3 | -20.1 | -20.8 | 2.4 |
| Sillitin Z 89 | 4 | -16.6 | -14.9 | 5.8 |
| Sillikolloid P 87 | 3 | -22.1 | -21.5 | -0.2 |
| Sillikolloid P 87 (2 phr DEG) | 3 | -19.8 | -16.9 | 5.0 |
| Silfit Z 91 | 3 | -19.3 | -36.2 | 3.3 |
| Aktifit AM | 5 | -6.7 | -28.7 | 15.2 |
| Aktisil AM | 2 | -5.1 | -24.3 | 8.4 |
| Aktisil PF 216 | 4 | 5.2 | -22.3 | 22.4 |
| Aktisil VM 56 | 3 | 5.4 | -16.6 | 13.2 |
| Aktisil VM 56/89 | 3 | -7.7 | -32.5 | 22.6 |
| Aktisil Q | 3 | -2.5 | -30.6 | 16.8 |
| Aktisil PF 777 | 3 | -14.6 | -16.3 | 11.8 |

# Hot air aging 168 h / 70 °C – Competitors

| | Change of hardness S2 specimen [Shore A] | Change of tensile strength [%] | Change of elongation at break [rel.%] | Change of modulus 100 % [%] |
|---|---|---|---|---|
| Carbon black N 550 | 2 | 5.4 | -7.9 | 27.1 |
| Pptd. silica 180 m²/g | 4 | -5.5 | -37.5 | 51.6 |
| Pptd. silica 180 m²/g (5 phr DEG) | 5 | 1.7 | -16.7 | 52.1 |
| Pptd. aluminum silicate | 5 | 9.7 | -27.3 | 42.2 |
| Pptd. aluminum silicate (2 phr DEG) | 5 | 9.7 | -16.9 | 44.0 |
| Pptd. calcium silicate | 7 | 1.7 | -17.4 | 45.1 |
| Pptd. calcium silicate (2 phr DEG) | 6 | -0.5 | -20.7 | 50.0 |
| French Hard Clay | 2 | -22.3 | -32.4 | 9.4 |
| French Hard Clay (2 phr DEG) | 2 | -19.6 | -11.9 | 6.6 |
| Engl. Hard Clay | 4 | -11.7 | -22.4 | 15.6 |
| Engl. Hard Clay (2 phr DEG) | 2 | -29.7 | -23.7 | 7.5 |
| Engl. Clay | 2 | -3.9 | -26.1 | 24.0 |
| Engl. Clay (2 phr DEG) | 3 | -16.4 | -14.8 | 18.5 |
| Engl. Soft Clay | 2 | -17.3 | -27.8 | 9.9 |
| Engl. Soft Clay (2 phr DEG) | 2 | -20.2 | -22.5 | 10.0 |
| Engl. calcined Clay | 3 | -4.9 | -23.9 | 14.4 |
| Americ. calcined Clay | 5 | -16.5 | -27.9 | 18.4 |
| Americ. calcined Clay, amino functio. | 4 | -4.0 | -30.4 | 19.8 |
| Americ. calcined Clay, vinyl functio. | 4 | 0.1 | -29.5 | 22.5 |
| Whiting | 4 | -30.9 | -27.9 | 13.2 |
| Whiting, stearate functio. | 4 | -19.7 | -17.8 | 16.4 |
| Americ. Talc | 1 | -17.6 | -20.8 | 15.8 |
| Americ. coated Talc, amino functio. | 2 | 11.2 | 2.0 | 23.5 |

# Hot air aging 168 h / 100 °C – Neuburg Siliceous Earth

| | Change of hardness S2 specimen [Shore A] | Change of tensile strength [%] | Change of elongation at break [rel.%] | Change of modulus 100 % [%] |
|---|---|---|---|---|
| Sillitin V 85 | 10 | -18.0 | -43.7 | 34.8 |
| Sillitin V 88 | 9 | -24.9 | -46.6 | 34.6 |
| Sillitin N 82 | 9 | -2.4 | -40.8 | 44.6 |
| Sillitin N 85 | 9 | -11.7 | -57.5 | 49.1 |
| Sillitin Z 86 | 8 | -7.3 | -45.9 | 47.9 |
| Sillitin Z 89 | 9 | -13.7 | -38.8 | 41.3 |
| Sillikolloid P 87 | 7 | -5.5 | -47.3 | 45.4 |
| Sillikolloid P 87 (2 phr DEG) | 8 | -14.4 | -37.3 | 35.8 |
| Silfit Z 91 | 8 | -10.7 | -60.6 | 30.7 |
| Aktifit AM | 9 | 6.2 | -46.9 | 50.9 |
| Aktisil AM | 5 | 6.8 | -42.2 | 38.0 |
| Aktisil PF 216 | 10 | 25.5 | -54.8 | 78.5 |
| Aktisil VM 56 | 9 | 23.3 | -50.4 | 65.8 |
| Aktisil VM 56/89 | 8 | 8.9 | -51.7 | 65.5 |
| Aktisil Q | 8 | 19.8 | -57.2 | 52.2 |
| Aktisil PF 777 | 10 | -9.5 | -35.8 | 48.4 |

# Hot air aging 168 h / 100 °C – Competitors

| | Change of hardness S2 specimen [Shore A] | Change of tensile strength [%] | Change of elongation at break [rel.%] | Change of modulus 100 % [%] |
|---|---|---|---|---|
| Carbon black N 550 | 4 | 5.0 | -28.4 | 57.0 |
| Pptd. silica 180 m²/g | 8 | -19.0 | -57.5 | 90.2 |
| Pptd. silica 180 m²/g (5 phr DEG) | 8 | -3.9 | -28.4 | 77.1 |
| Pptd. aluminum silicate | 8 | 8.7 | -53.9 | 95.0 |
| Pptd. aluminum silicate (2 phr DEG) | 9 | 11.5 | -32.3 | 76.2 |
| Pptd. calcium silicate | 11 | 13.9 | -27.0 | 84.8 |
| Pptd. calcium silicate (2 phr DEG) | 10 | 2.3 | -39.0 | 107.6 |
| French Hard Clay | 8 | -3.4 | -57.3 | 73.1 |
| French Hard Clay (2 phr DEG) | 6 | -15.6 | -38.5 | 47.9 |
| Engl. Hard Clay | 8 | 3.2 | -40.3 | 62.4 |
| Engl. Hard Clay (2 phr DEG) | 8 | -21.7 | -45.2 | 57.6 |
| Engl. Clay | 6 | 5.9 | -53.4 | 67.1 |
| Engl. Clay (2 phr DEG) | 8 | -9.4 | -44.2 | 55.8 |
| Engl. Soft Clay | 8 | 2.4 | -55.6 | 54.9 |
| Engl. Soft Clay (2 phr DEG) | 7 | -16.4 | -44.9 | 35.2 |
| Engl. calcined Clay | 7 | -7.5 | -48.5 | 31.1 |
| Americ. calcined Clay | 9 | -20.6 | -47.7 | 37.9 |
| Americ. calcined Clay, amino functio. | 8 | 10.2 | -45.6 | 50.5 |
| Americ. calcined Clay, vinyl functio. | 6 | 12.3 | -52.2 | 41.6 |
| Whiting | 9 | -36.5 | -46.0 | 35.0 |
| Whiting, stearate functio. | 9 | -25.9 | -32.3 | 28.2 |
| Americ. Talc | 5 | -16.9 | -34.2 | 34.0 |
| Americ. coated Talc, amino functio. | 6 | 13.9 | -32.8 | 39.1 |

# Immersion in deionized water 168 h / 95 °C – Neuburg Siliceous Earth

| | Change of hardness S2 specimen [Shore A] | Change of tensile strength [%] | Change of elongation at break [rel.%] | Change of weight [%] | Change of volume [%] |
|---|---|---|---|---|---|
| Sillitin V 85 | 4 | -18.5 | -18.1 | 3.8 | 5.7 |
| Sillitin V 88 | 4 | -24.7 | -19.7 | 3.5 | 5.1 |
| Sillitin N 82 | 4 | -12.4 | -18.2 | 3.1 | 4.5 |
| Sillitin N 85 | 3 | -22.6 | -38.0 | 4.0 | 6.0 |
| Sillitin Z 86 | 3 | -20.1 | -20.8 | 3.2 | 4.7 |
| Sillitin Z 89 | 4 | -16.6 | -14.9 | 3.2 | 4.5 |
| Sillikolloid P 87 | 3 | -22.1 | -21.5 | 2.9 | 4.3 |
| Sillikolloid P 87 (2 phr DEG) | 3 | -19.8 | -16.9 | 2.6 | 3.7 |
| Silfit Z 91 | 3 | -19.3 | -36.2 | 2.4 | 3.3 |
| Aktifit AM | 5 | -6.7 | -28.7 | 2.2 | 2.5 |
| Aktisil AM | 2 | -5.1 | -24.3 | 3.2 | 4.7 |
| Aktisil PF 216 | 4 | 5.2 | -22.3 | 2.7 | 3.7 |
| Aktisil VM 56 | 3 | 5.4 | -16.6 | 2.8 | 3.6 |
| Aktisil VM 56/89 | 3 | -7.7 | -32.5 | 2.5 | 3.4 |
| Aktisil Q | 3 | -2.5 | -30.6 | 8.0 | 11.6 |
| Aktisil PF 777 | 3 | -14.6 | -16.3 | 3.2 | 4.3 |

# Immersion in deionized water 168 h / 95 °C – Competitors

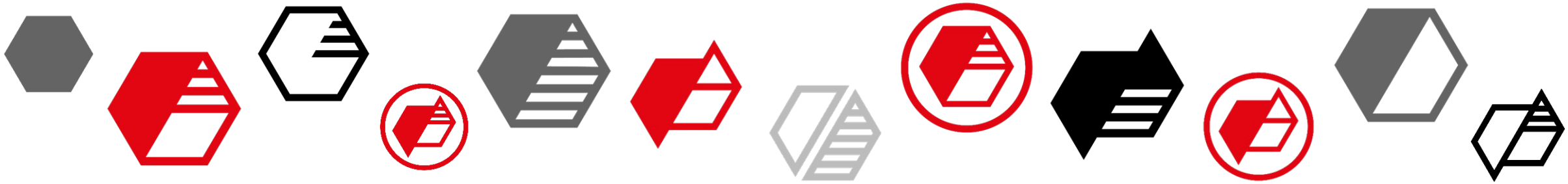
| | Change of hardness S2 specimen [Shore A] | Change of tensile strength [%] | Change of elongation at break [rel.%] | Change of weight [%] | Change of volume [%] |
|---|---|---|---|---|---|
| Carbon black N 550 | 2 | 5.4 | -7.9 | 1.8 | 1.2 |
| Pptd. silica 180 m²/g | 4 | -5.5 | -37.5 | 7.6 | 7.3 |
| Pptd. silica 180 m²/g (5 phr DEG) | 5 | 1.7 | -16.7 | 7.3 | 8.0 |
| Pptd. aluminum silicate | 5 | 9.7 | -27.3 | 8.7 | 11.1 |
| Pptd. aluminum silicate (2 phr DEG) | 5 | 9.7 | -16.9 | 6.9 | 9.4 |
| Pptd. calcium silicate | 7 | 1.7 | -17.4 | 8.4 | 8.5 |
| Pptd. calcium silicate (2 phr DEG) | 6 | -0.5 | -20.7 | 8.5 | 8.8 |
| French Hard Clay | 2 | -22.3 | -32.4 | 4.0 | 5.8 |
| French Hard Clay (2 phr DEG) | 2 | -19.6 | -11.9 | 3.4 | 4.6 |
| Engl. Hard Clay | 4 | -11.7 | -22.4 | 6.2 | 8.9 |
| Engl. Hard Clay (2 phr DEG) | 2 | -29.7 | -23.7 | 5.5 | 8.0 |
| Engl. Clay | 2 | -3.9 | -26.1 | 3.6 | 5.0 |
| Engl. Clay (2 phr DEG) | 3 | -16.4 | -14.8 | 3.4 | 4.7 |
| Engl. Soft Clay | 2 | -17.3 | -27.8 | 2.9 | 3.4 |
| Engl. Soft Clay (2 phr DEG) | 2 | -20.2 | -22.5 | 3.3 | 4.1 |
| Engl. calcined Clay | 3 | -4.9 | -23.9 | 2.3 | 2.1 |
| Americ. calcined Clay | 5 | -16.5 | -27.9 | 1.9 | 1.8 |
| Americ. calcined Clay, amino functio. | 4 | -4.0 | -30.4 | 1.5 | 1.2 |
| Americ. calcined Clay, vinyl functio. | 4 | 0.1 | -29.5 | 2.0 | 1.9 |
| Whiting | 4 | -30.9 | -27.9 | 3.3 | 4.5 |
| Whiting, stearate functio. | 4 | -19.7 | -17.8 | 2.3 | 2.9 |
| Americ. Talc | 1 | -17.6 | -20.8 | 4.9 | 7.4 |
| Americ. coated Talc, amino functio. | 2 | 11.2 | 2.0 | 3.9 | 5.6 |

# Garvey extrusion – Neuburg Siliceous Earth

| | Assessment Garvey profile at 2.0 m/min. haul-off speed | | | | Extruder torque at 2.0 m/min. [Nm] | Max. extrusion speed with Garvey profile 4444 haul-off speed [m/min.] | Max. extrusion speed with Garvey profile 4444 Extruder torque [Nm] |
|---|---|---|---|---|---|---|---|
| | swelling | 30° edge | surface | corners | | | |
| Sillitin V 85 | 4.0 | 2 | 4 | 4.0 | 140 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Sillitin V 88 | 4.0 | 2 | 4 | 4.0 | 135 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Sillitin N 82 | 4.0 | 2 | 4 | 4.0 | 135 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Sillitin N 85 | 4.0 | 2 | 4 | 4.0 | 135 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Sillitin Z 86 | 4.0 | 4 | 4 | 4.0 | 140 | 2.0 | 140 |
| Sillitin Z 89 | 4.0 | 4 | 4 | 4.0 | 140 | 4.5 | 160 |
| Sillikolloid P 87 | 4.0 | 3.5 | 4 | 4.0 | 145 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Sillikolloid P 87 (2 phr DEG) | 4.0 | 4 | 4 | 4.0 | 145 | 4.0 | 165 |
| Silfit Z 91 | 4.0 | 4 | 4 | 4.0 | 145 | 5.5 | 170 |
| Aktifit AM | 4.0 | 4 | 4 | 4.0 | 145 | 10.0 | 190 |
| Aktisil AM | 4.0 | 4 | 4 | 4.0 | 130 | 3.0 | 150 |
| Aktisil PF 216 | 4.0 | 4 | 4 | 4.0 | 130 | 6.0 | 165 |
| Aktisil VM 56 | 4.0 | 4 | 4 | 4.0 | 140 | 4.5 | 145 |
| Aktisil VM 56/89 | 4.0 | 4 | 4 | 4.0 | 140 | 7.0 | 160 |
| Aktisil Q | 4.0 | 4 | 4 | 4.0 | 120 | 4.5 | 150 |
| Aktisil PF 777 | 4.0 | 4 | 4 | 4.0 | 130 | 4.5 | 155 |

# Garvey extrusion – Competitors

| | Assessment Garvey profile at 2.0 m/min. haul-off speed | | | | Extruder torque at 2.0 m/min. [Nm] | Max. extrusion speed with Garvey profile 4444 haul-off speed [m/min.] | Max. extrusion speed with Garvey profile 4444 Extruder torque [Nm] |
|---|---|---|---|---|---|---|---|
| | swelling | 30° edge | surface | corners | | | |
| Carbon black N 550 | 4.0 | 4 | 4 | 4.0 | 150 | 13.0 (higher speed possible) | 200 |
| Pptd. silica 180 m²/g | 4.0 | 1.5 | 4 | 3.3 | 180 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Pptd. silica 180 m²/g (5 phr DEG) | 4.0 | 1.5 | 4 | 3.2 | 165 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Pptd. aluminum silicate | 4.0 | 1 | 3.5 | 2.2 | 160 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Pptd. aluminum silicate (2 phr DEG) | 4.0 | 1 | 3.5 | 2.2 | 150 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Pptd. calcium silicate | 4.0 | 1.5 | 4 | 3.5 | 145 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Pptd. calcium silicate (2 phr DEG) | 4.0 | 1.5 | 4 | 2.2 | 145 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| French Hard Clay (5 phr DEG) | 4.0 | 1 | 3 | 1.3 | 115 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Engl. Hard Clay (5 phr DEG) | 4.0 | 1.5 | 4 | 2.0 | 130 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Engl. Clay (2 phr DEG) | 4.0 | 1 | 4 | 2.8 | 120 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Engl. Soft Clay | 4.0 | 1.5 | 4 | 2.8 | 110 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Engl. Soft Clay (2 phr DEG) | 4.0 | 1.5 | 4 | 2.0 | 110 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Engl. calcined Clay | 4.0 | 4 | 4 | 4.0 | 140 | 3.0 | 140 |
| Americ. calcined Clay | 4.0 | 4 | 4 | 4.0 | 130 | 4.0 | 145 |
| Americ. calcined Clay, amino functio. | 4.0 | 4 | 4 | 4.0 | 120 | 5.5 | 150 |
| Americ. calcined Clay, vinyl functio. | 4.0 | 4 | 4 | 4.0 | 120 | 2.5 | 130 |
| Whiting | 4.0 | 2.5 | 4 | 3.3 | 110 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Whiting, stearate functio. | 4.0 | 2.5 | 4 | 3.3 | 105 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Americ. Talc | 4.0 | 2.5 | 3.5 | 2.7 | 100 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |
| Americ. coated Talc, amino functio. | 4.0 | 1.5 | 3 | 2.2 | 110 | Already at 2 m/min. no 4444 assessment reached | Already at 2 m/min. no 4444 assessment reached |



→ back to results

# Images Garvey extrudates

back to diagram

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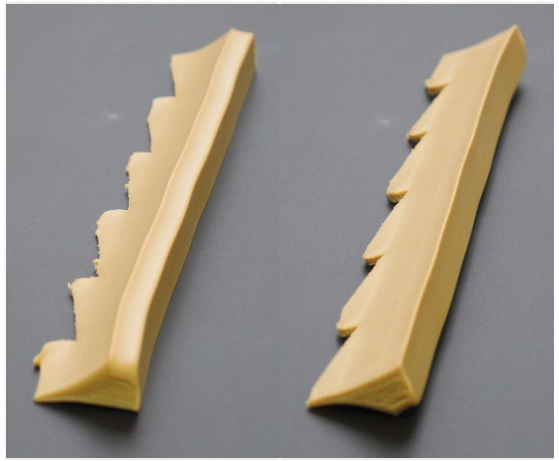
# Garvey extrusion - extrudates at 2.0 m/min. haul-off speed

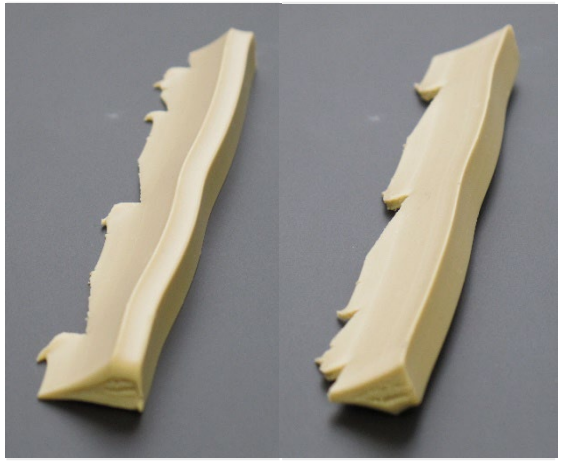
Sillitin V 85

front | back



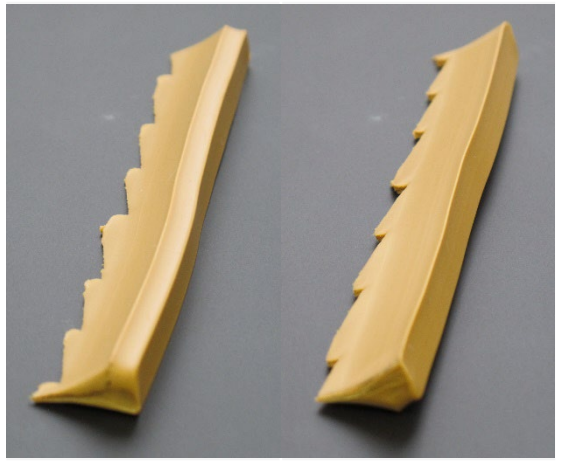
Sillitin V 88

front | back



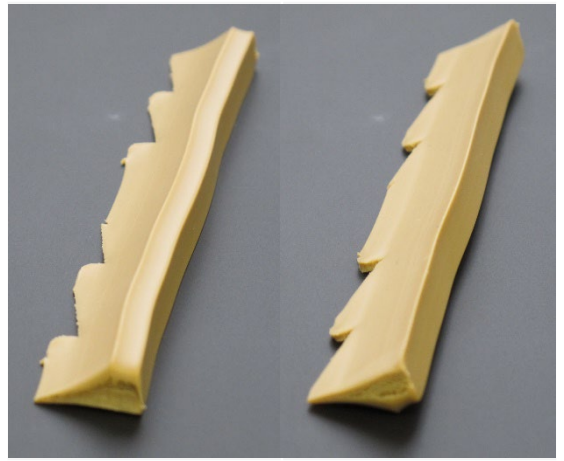
Sillitin N 82

front | back



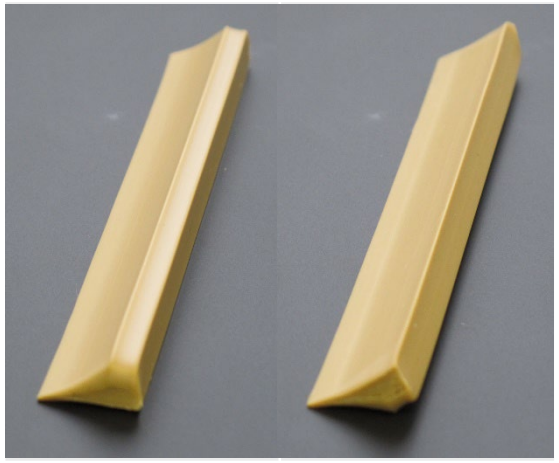
Sillitin N 85

front | back



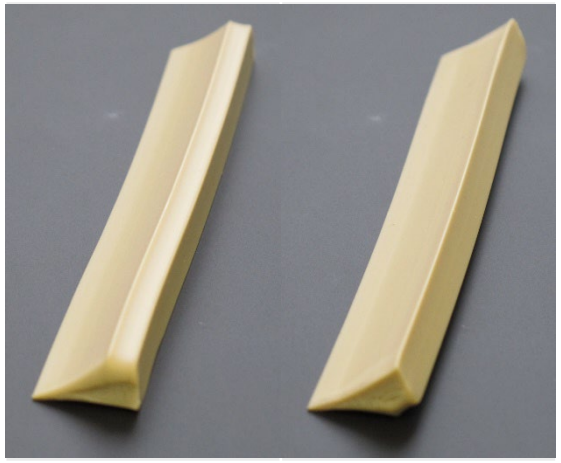
Sillitin Z 86

front | back



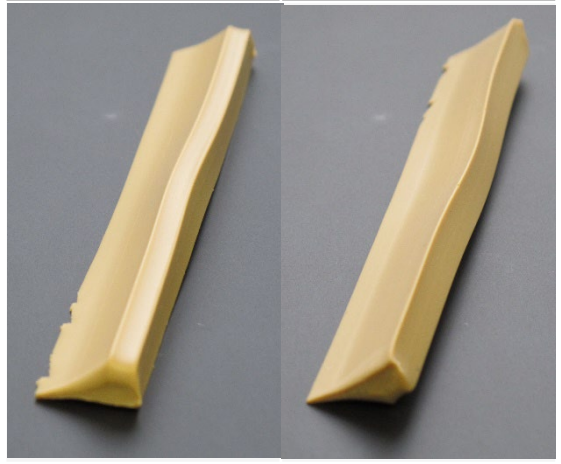
Sillitin Z 89

front | back



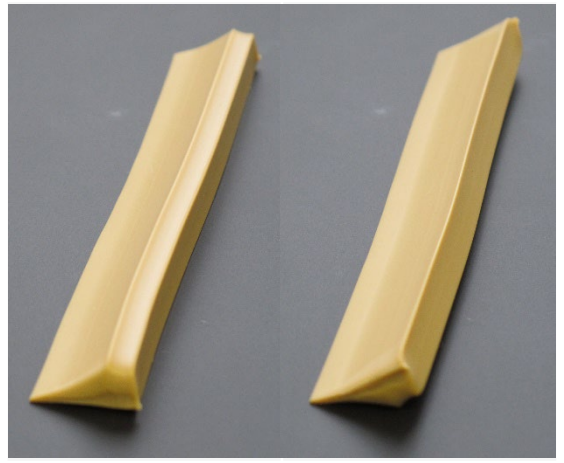
Sillikolloid P 87

front | back



Sillikolloid P 87 with DEG

front | back



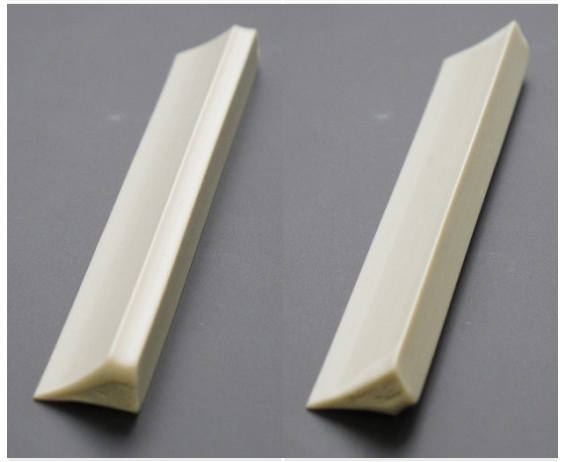


back to diagram

# Garvey extrusion - extrudates at 2.0 m/min. haul-off speed

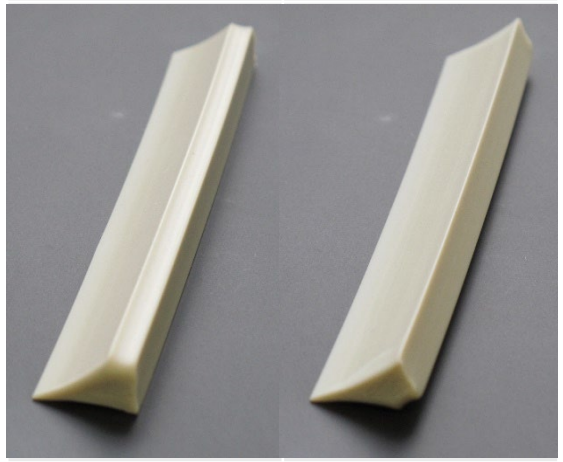
Silfit Z 91

front | back



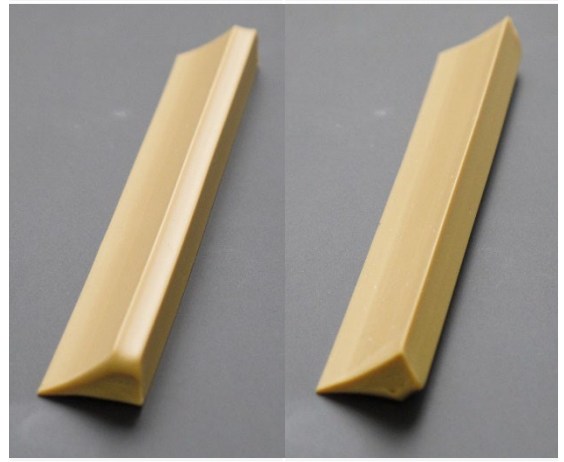
Aktifit AM

front | back



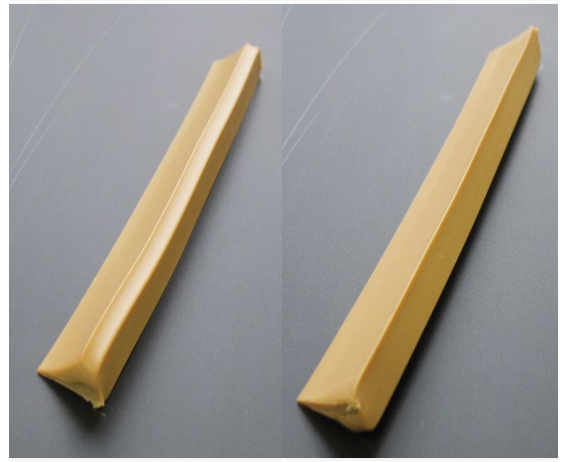
Aktisil AM

front | back



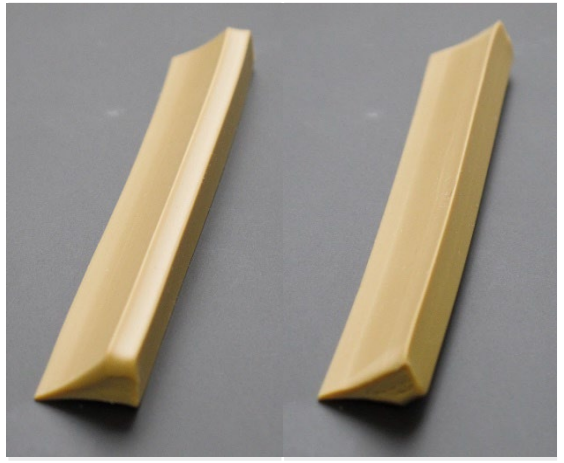
Aktisil PF 216

front | back



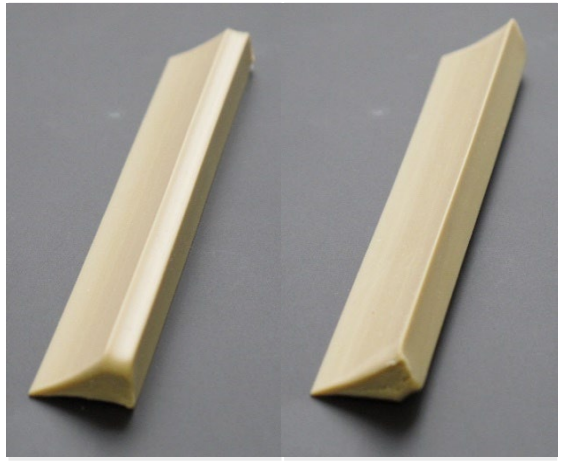
Aktisil VM 56

front | back



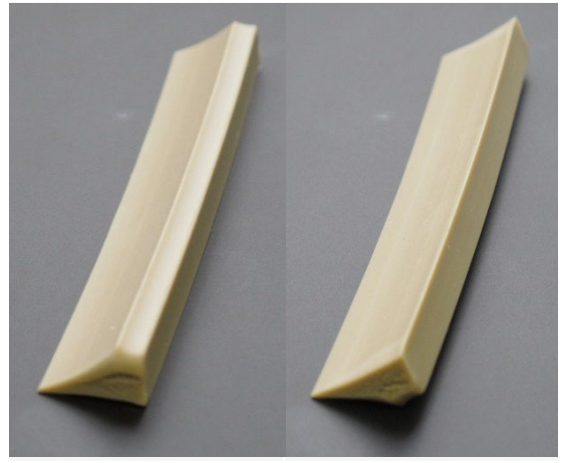
Aktisil VM 56/89

front | back



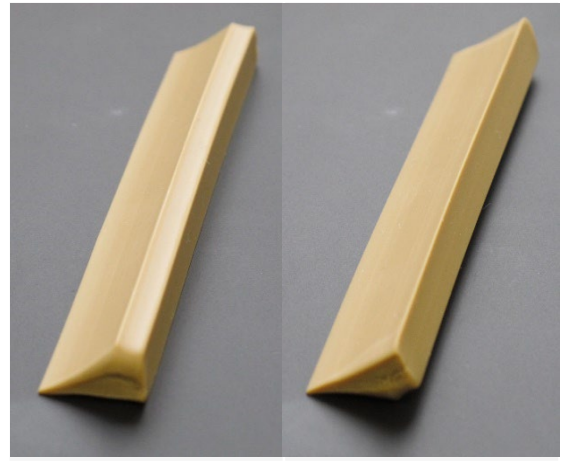
Aktisil Q

front | back

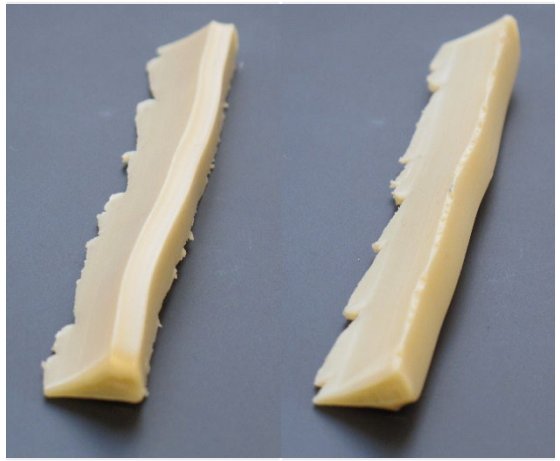
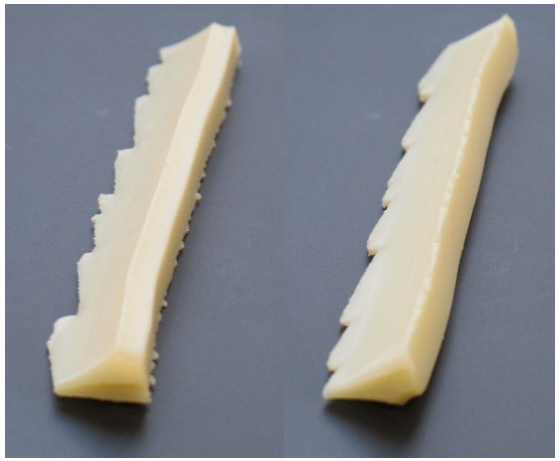
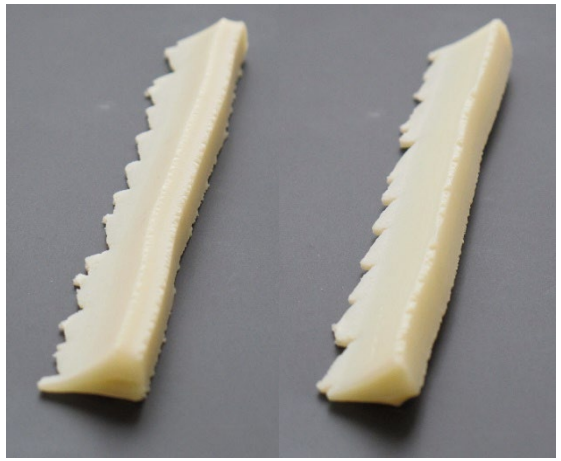


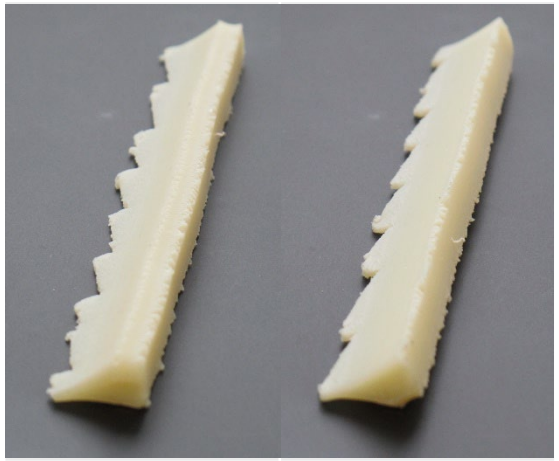
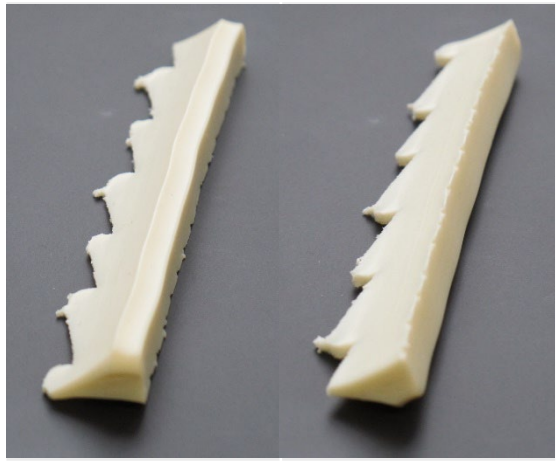
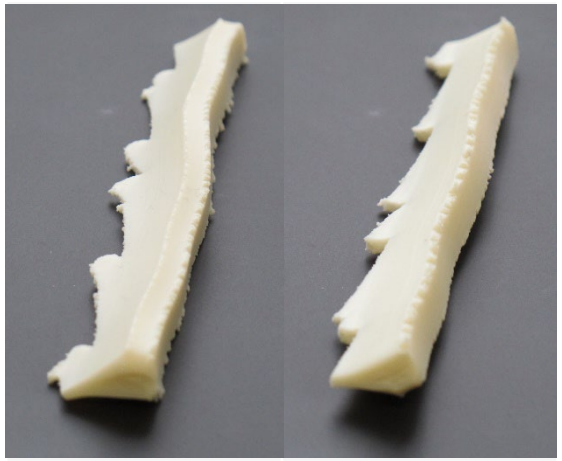
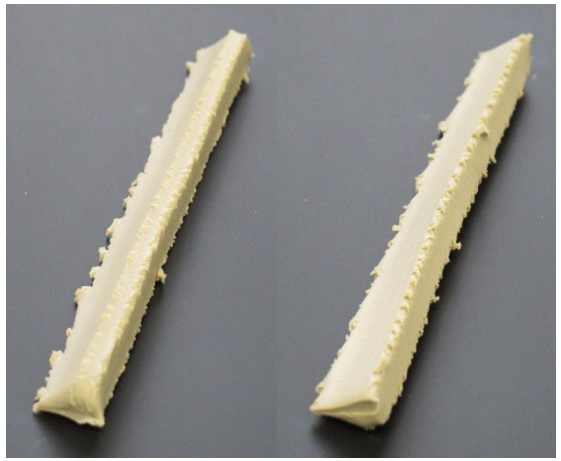
Aktisil PF 777

front | back



# Garvey extrusion - extrudates at 2.0 m/min. haul-off speed

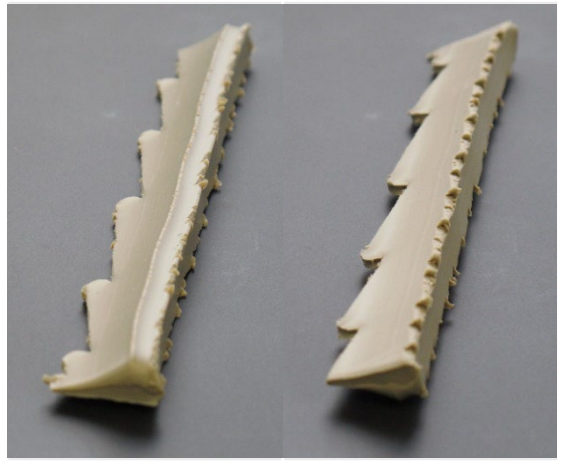
| Carbon black N 550 | | Pptd. silica 180 m²/g | | Pptd. silica 180 m²/g with DEG | | Pptd. aluminum silicate | |
|---|---|---|---|---|---|---|---|
| front | back | front | back | front | back | front | back |
|  | |  | |  | |  | |

| Pptd. aluminum silicate with DEG | | Pptd. calcium silicate | | Pptd. calcium silicate with DEG | | French Hard Clay with DEG | |
|---|---|---|---|---|---|---|---|
| front | back | front | back | front | back | front | back |
|  | |  | |  | |  | |

# Garvey extrusion - extrudates at 2.0 m/min. haul-off speed

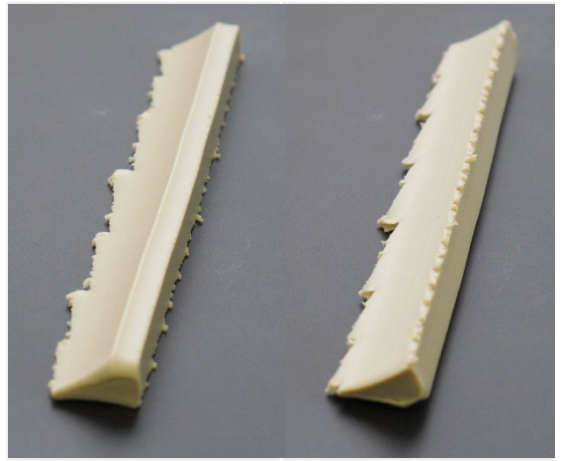
Engl. Hard Clay with DEG

front | back



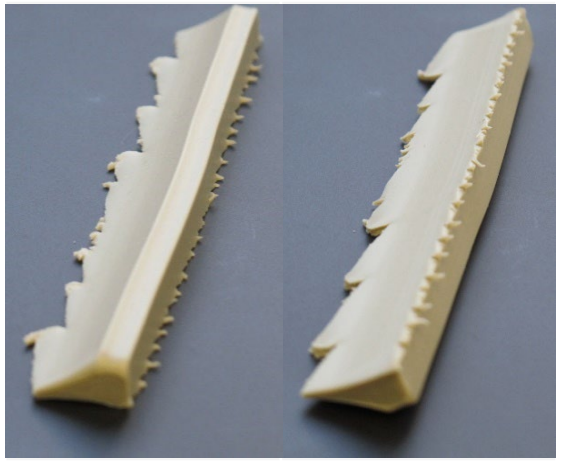
Engl. Clay with DEG

front | back



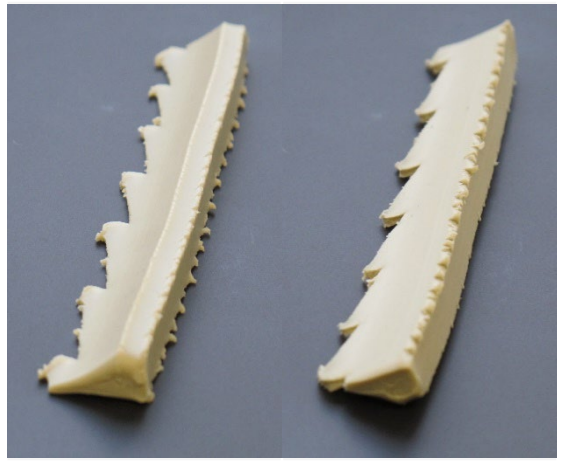
Engl. Soft Clay

front | back



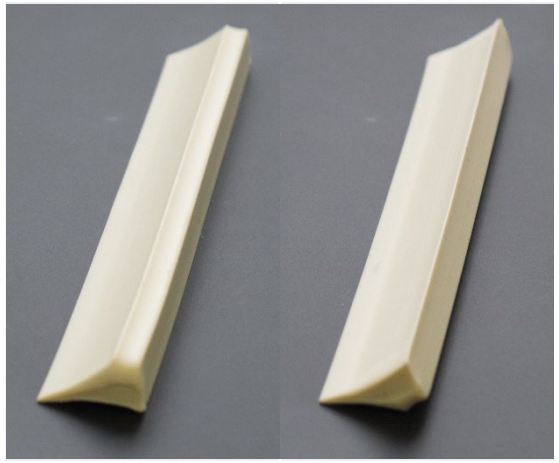
Engl. Soft Clay with DEG

front | back



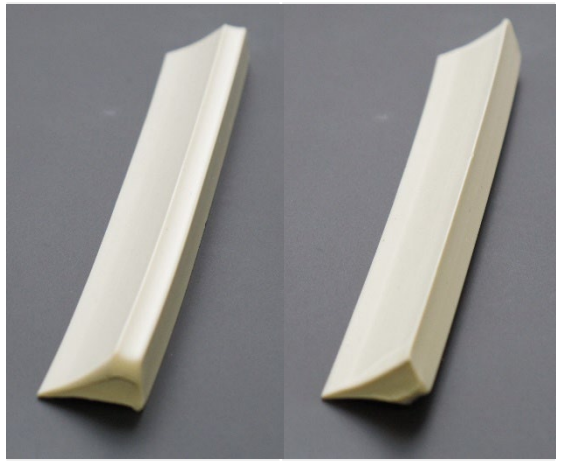
Engl. calcined Clay

front | back



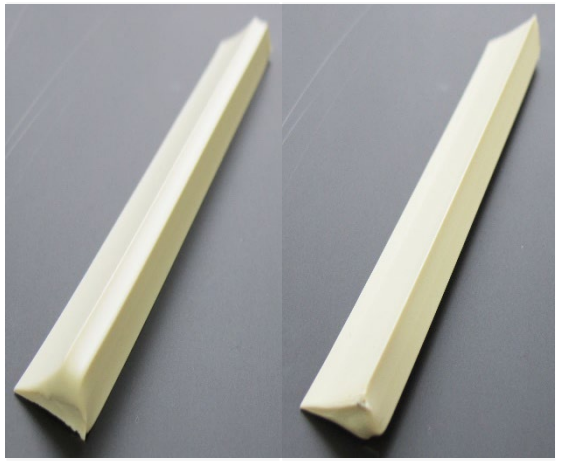
Americ. calcined Clay

front | back



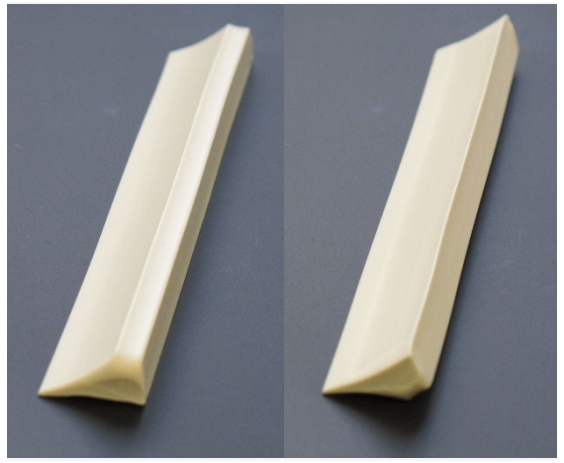
Americ. calcined Clay, amino functio.

front | back



Americ. calcined Clay, vinyl functio.

front | back





back to diagram

# Garvey extrusion - extrudates at 2.0 m/min. haul-off speed

| Whiting | | Whiting, stearate functio. | | Americ. Talc | | Americ. coated Talc, amino functio. | |
|---|---|---|---|---|---|---|---|
| front | back | front | back | front | back | front | back |