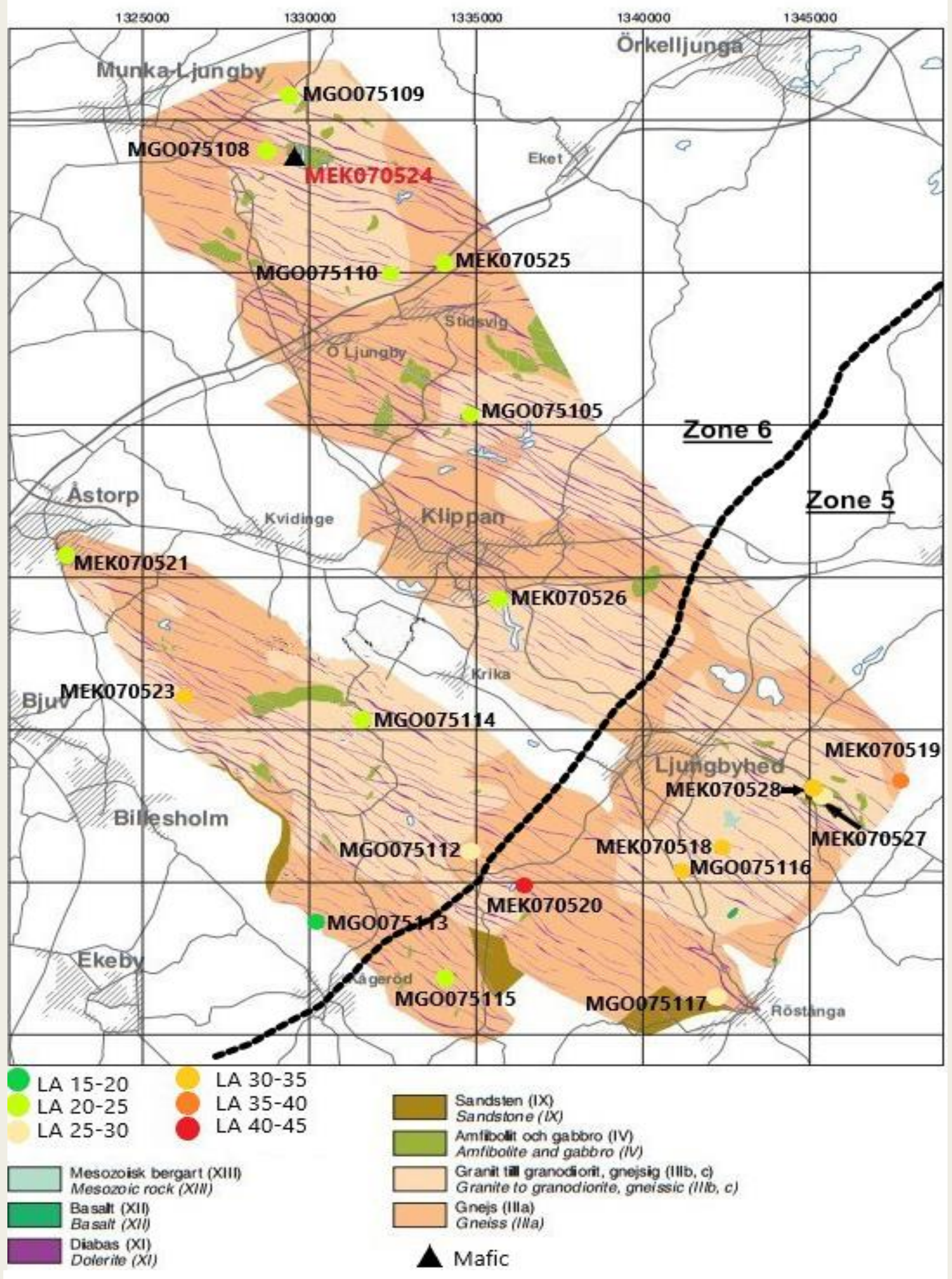
Metamorphic microtextures and mineral assemblages in orthogneisses in northern Skåne – how do they correlate with technical properties?

MSc project (45 ECTS credits), Department of Geology, LU, 2020

MSc student: Maria Eleni Taxopoulou

Supervisor: Charlotte Möller



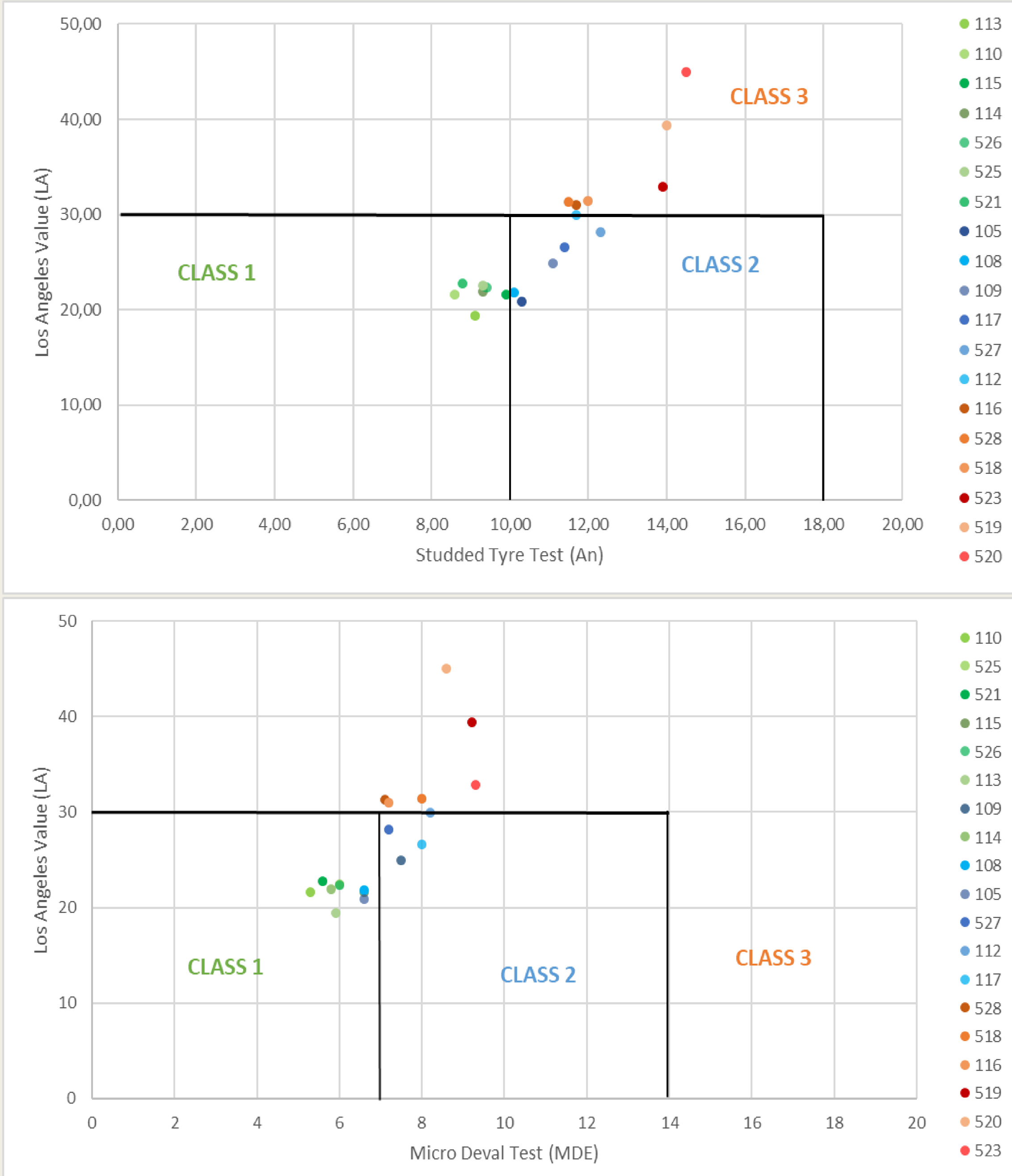
Simplified bedrock map and sample sites with the LA values for each sample (Persson & Göransson, 2010). The black dashed line represents the south extension of the border between metamorphic zone 5 and 6 (after Möller & Andersson, 2018). Map modified from Persson & Göransson (2010; based on Norling & Wikman (1990), Wikman et. al. (1993), Sivhed & Wikman (1986) and Wikman & Sivhed (1992)).

AIM: Correlation of the **technical quality** of the orthogneisses in NW Skåne with :

- Mineralogy
- Grain size & grain properties (grain complexity, circularity, degree of elongation etc.)
- Metamorphic grade & degree of deformation
- Microfractures

BACKGROUND

The study area is located in Söderåsen, SW Sweden. This area belongs to the internal part of the Eastern Segment, part of the Sveconorwegian Orogen (1.14-0.90 Ga). It consists of 1.81-1.64 Ga deformed gneissic granitoids with minor younger, gabbroic to syenitoid intrusions. The area was subjected to high grade metamorphic conditions of upper amphibolite- up to granulite- facies, and belongs to the metamorphic zones 5 and 6 of the Eastern Segment (Möller & Andersson, 2018). The 19 orthogneiss samples have been investigated from the SGU and different technical analyses were performed (Los Angeles value test, MicroDeval test, Studded Tyre test), in order to determine their suitabiliy to be used as road and railway aggregates.



Diagrams showing the technical test results for metagranitic rocks in the Söderåsen area, from Persson & Göransson (2010), with sample color code added for road-material based on LA and A_N /M_{DE} (greens= class 1; blues= class 2; reds class 3), Upper diagram: Studded Tyre Test value (A_N) vs Los Angeles-value (LA). Lower diagram: MicroDeval (M_{DE}) value vs Los Angeles-value (LA).

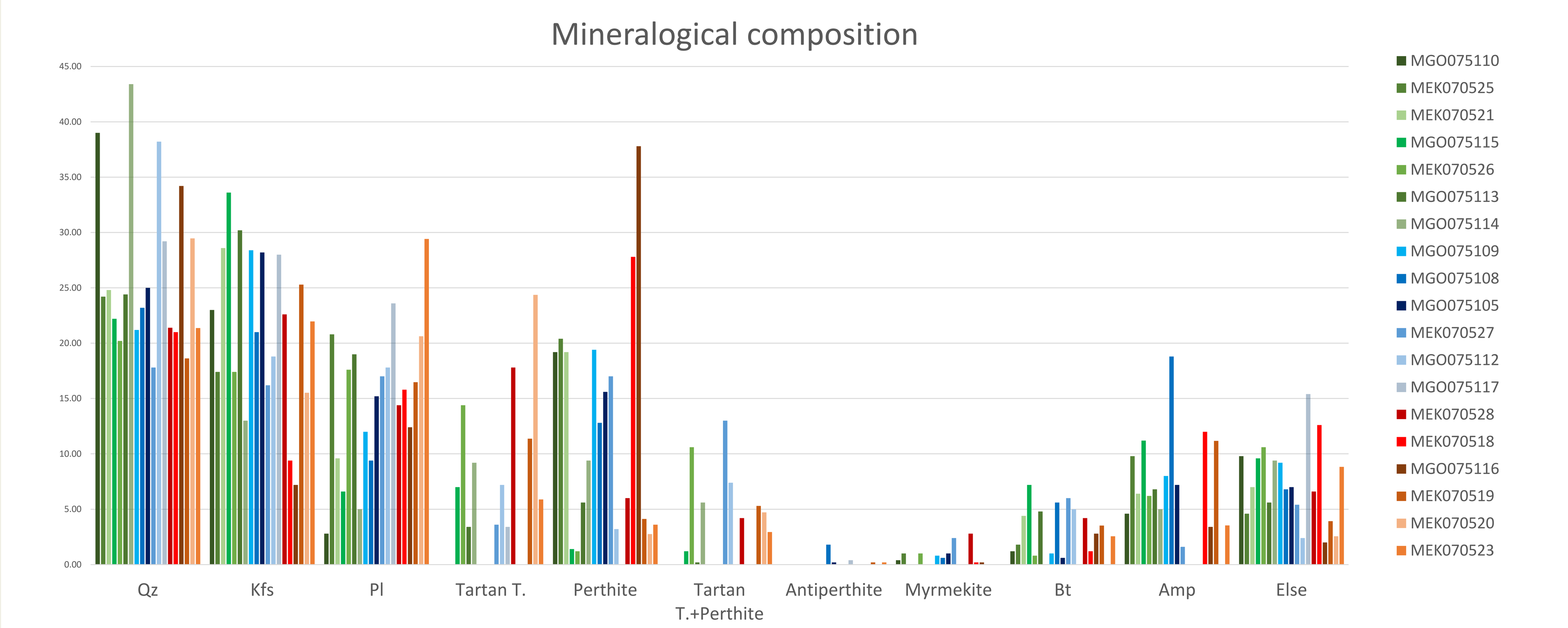


Chart with the mineralogical composition of each sample for the main phases, after the point counting method. Green = class 1, blue = class 2, red = class 3 samples

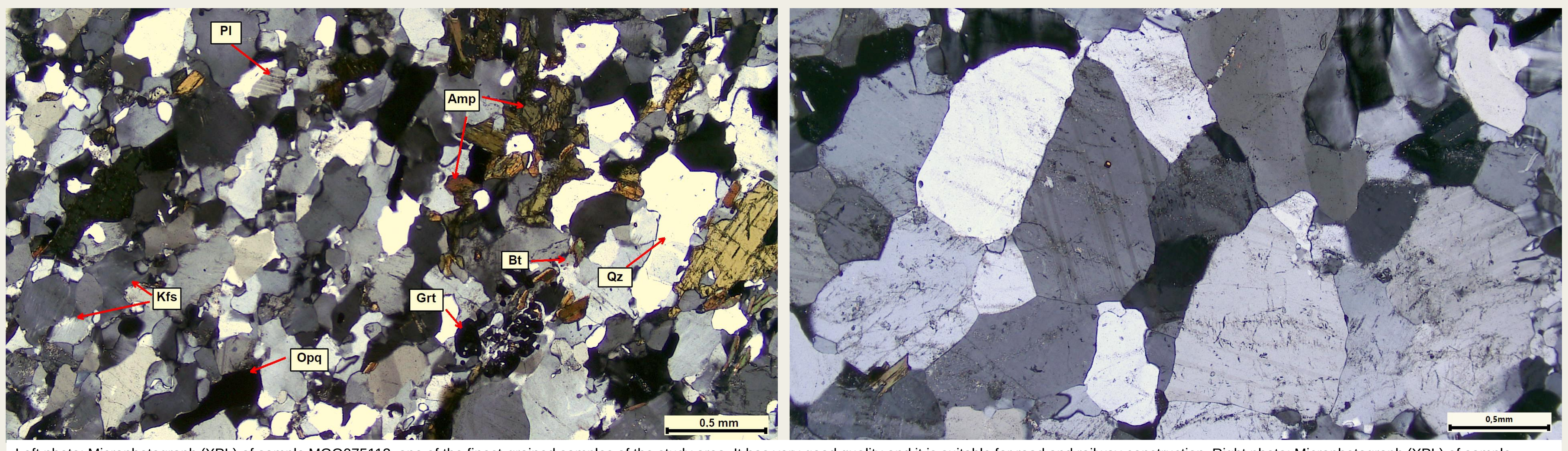
SGU CLASSIFICATION

The Geological Survey of Sweden has classified the aggregate quality of the samples in relation to their suitability. Class 1 refers to the most suitable samples for highway and railroad construction, class 2 is suitable mostly for railorads, whereas class 3 is suitable to be used only as aggregates. The technical quality of the samples is related to the metamorphic conditions, the mineralogy, the grain size, the degree of interlocking and the amount of very fine-grained material.

METHODS

The rocks were investigated macroscopically and microscopically, and the modal composition of the mineral montent was determined with the pointing counting method. The grain size analysis was conducted using scanned 2D photographs of the thin sections under crossed polarizers, using an image analysis software. 300 grains were measured manually per thin section, in order to calculate the grain perimeter. From these measurements, the average area, perimeter, circularity and aspect ratio were calculated.

The measurements show that the technical quality is strongly connected to the mineralogy and the grain size. Most of the samples of class 1 are fine-grained and they have high amount of quartz minerals. The area measurements show that the samples with high amount of small grains have higher quality. The aspect ratio shows that most of the samples from classes 1 and 2 have elongated grains, in contrast to the samples from class 3 that are coarse-grained and usually undeformed. However, the circularity measurements show that the samples from class 3 have more irregular grains.



Left photo: Microphotograph (XPL) of sample MGO075113, one of the finest-grained samples of the study area. It has very good quality and it is suitable for road and railway construction. Right photo: Microphotograph (XPL) of sample MEK070527, belonging to the samples with very poor quality. The difference between the two samples is particularly in the grain size and the grain complexity.

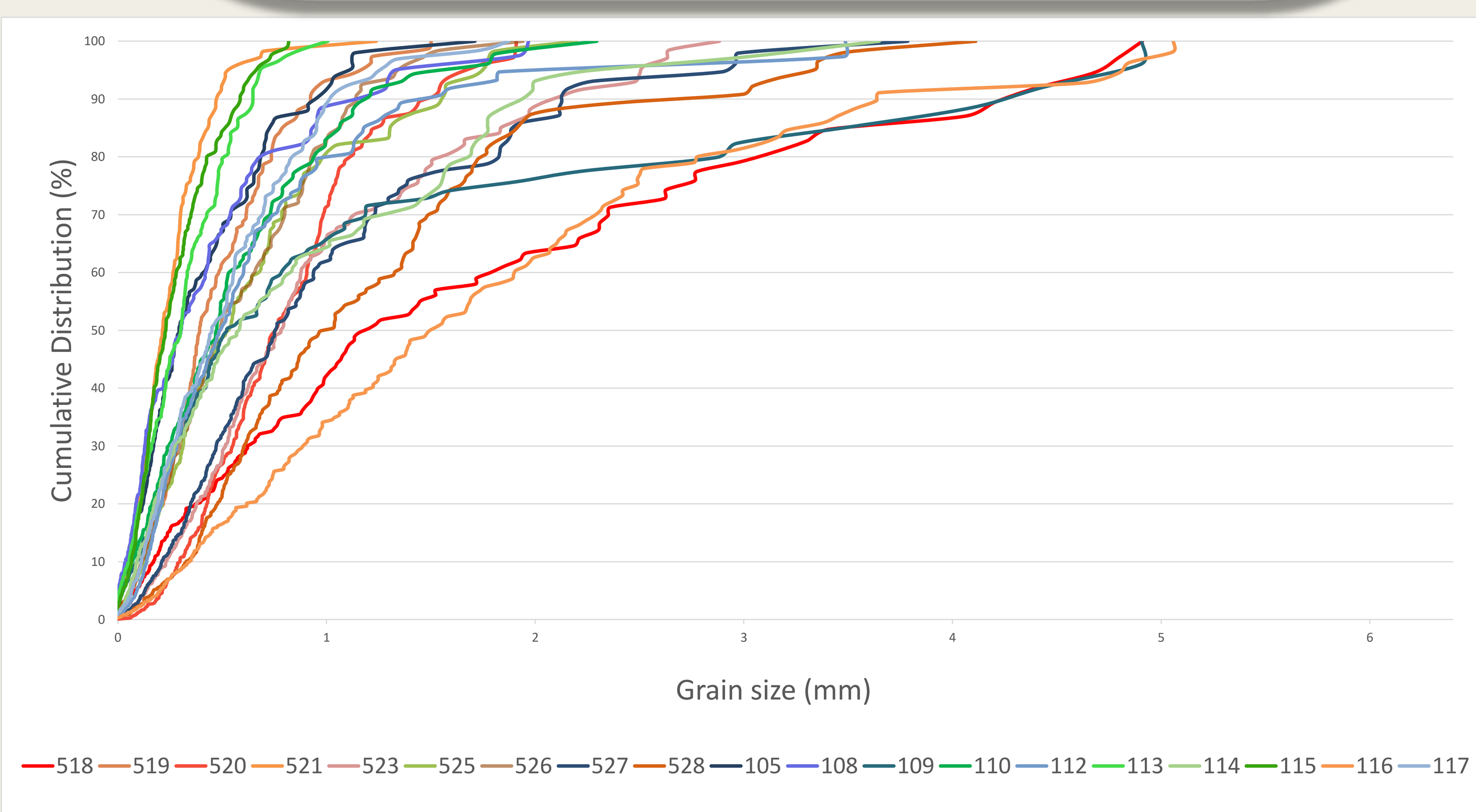
RESULTS

The technical properties of the granitoid rocks are contigent of many factors. The metamorphic degree is an important one that affects the quality of the samples in the study area. The samples that underwent higher meramorphic conditions and belong to zone 6 (NW part of the study area) are more deformed and their technical quality is better than that of the samples in zone 5 (SE part).

In relation to mineralogy, the samples with good quality present higher **quartz** percentage and lower **feldspar**, and they show higher amount of **perthitic exsolution in K-feldspar**. The biotite and amphibole content is approximately the same in all three classes. The samples with lower quality include higher percentage of **titanite** and very **low garnet** and **apatite**.

The samples with higher quality are generally fine-grained, and they include high amounts of very fine-grained material. They have high amount of elongated crystals, meaning that the degree of deformation is higher in that area. The grains do not show very complex grain boundaries in the deformed samples, possibly due to the fact that the deformation process reduces the grain size and makes the boundaries less amoeboid.

The presence of microcracks in these samples does not appear to have a major influence in their technical quality, as their appearance is similar in samples from different classes.



Cumulative mineral grain size distribution for every sample, based on the Feret's diameter

References

Möller, C. & Andersson, J., 2018: Metamorphic zoning and behavior of an underthrusting continental plate. *Journal of Metamorphic Geology. 36*, 567-589

Persson, L. & Göransson, M., 2010: Beskrivning till bergkvalitetskartan, Söderåsens kommun. *Sveriges geologiska Undersökning*

Norling, E. & Wikman, H., 1990: Beskrivning till berggrundskarta Höganäs NO/Helsingborg NV. Sveriges geologiska undersökning Af 129. 123 pp.

Sivhed, U. & Wikman, H., 1986: Beskrivning till berggrundskarta Helsingborg SV. Sveriges geologiska undersökning Af 149. 108 pp.

Wikman, H. & Sivhed, U., 1992: Beskrivning till berggrundskarta Helsingborg NO. Sveriges geologiska undersökning Af 148, 22–28

Maria Eleni Taxopoulou | ma3733ta-s@student.lu.se | Lund University | Department of Geology | Sölvegatan 12, 223 62, Lund, Sweden | +46 46 222 00 00 |