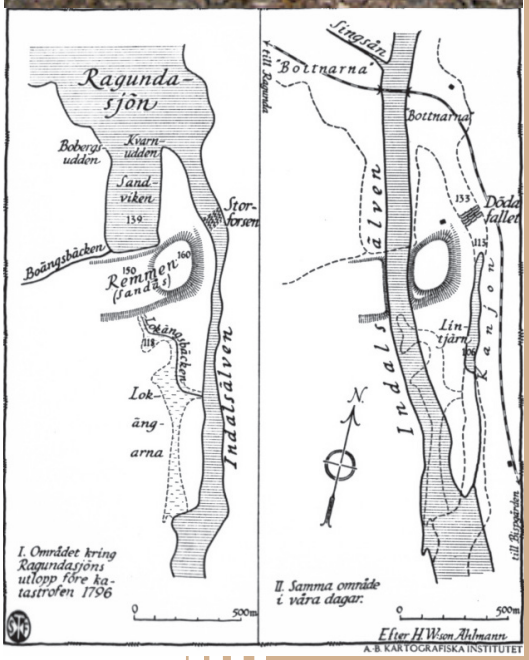
GEOLOGICA consult

Evaluation of the geological heritage of the Ragunda area

- WITH FOCUS ON THE GEOPARK POTENTIAL

Prepared for:
Världsarv Ragundadalen AB



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CONTENTS

1. Background and introduction 1
2. Suitability of consultant 1
3. Geology of the Ragunda area 1
3.1. The Precambrian era 2
3.2. Quaternary development 3
3.3. The “Huss event” 5
4. Conclusion and initial assessment 6

Photos: Christian Weiss (left) and SGU (right)

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1. BACKGROUND AND INTRODUCTION

For several years there have been ongoing preparations for entering a World Heritage Site evaluation process for the Ragunda area. This project stranded during 2020 due to the reluctance of the Swedish National Heritage Board to promote such an application referring to the already large number of World Heritage sites in Sweden. The Ragunda project was advised to investigate the possibilities to become a Geopark instead.

The author of this report was contacted in November 2020 by Peter Ladan regarding the possibilities to investigate the geological background and the potential of establishing geosites in the area. The task was accepted and work commenced.

2. SUITABILITY OF CONSULTANT

The consultant and author of this report, Emma Rehnström of Geologica Consult Sweden, has got over 20 years of work experience in the field of geology. Her work brought her abroad for about 15 years, gaining experience of geology on the international arena. Since 2015 she runs her own consultancy, working on a wide portfolio, but focusing on popularization and out-reach project in geology. Some key projects she has been involved in include:

- writing the geological descriptions and the application to Svensk Geopark for geopark project Siljan
- making new geology exhibitions at the mining museums in Bjuv and Nyvång
- establishing the network Geoforum Skåne for local stakeholders in geotourism in Skåne
- initiating project Geopark Skåne
- developing the child education concept Geokids.

She was awarded the prize “Geologist of the Year” in Sweden in 2020 and she is the newly elected chairwoman of the Swedish Geological Society.

3. GEOLOGY OF THE RAGUNDA AREA

The Ragunda area is host to several noteworthy geological phenomena. Below follows a short summary of the geological evolution in the area.

3.1. THE PRECAMBRIAN ERA

Bedrock of the Svekokarelian Province constitutes the oldest rocks in the area and consists of variably metamorphosed surface rocks, mainly sedimentary, such as greywacke, as well as plutonic rocks of primarily granitic composition. These rocks formed under a protracted compressive tectonic regime that affected a vast region of northern Sweden and Finland between 2000-1700 million years ago. In the Ragunda area the formation ages of the oldest rocks are around 1900-1800 million years old[1].

These rocks were intruded by the bimodal, anorogenic Ragunda Complex suite of rocks around 1500 million years age[2]. The Ragunda Complex consist of three major rock types: Granite, gabbro and syenite. However, it is the complex interaction between different immiscible magmas that make these rocks special. The Ragunda granite is characterized as a “Rapakivi granite”, which is a geological term adopted from a Finnish expression meaning weathering or rotten stone. This annotation comes from the fact that the rapakivi granites often are the subject of severe gravel weathering. This is caused by the differential weathering of layers of feldspar of different chemical composition. Large layered grains of feldspar is a characteristic feature of rapakivi granites. The rapakivi suite is present in an E-W corridor across Sweden, continuing into mid- and southern Finland. It is the current interpretation that these intrusives form the remains of an abandoned rift 1500 million years ago, possibly a so-called triple junction. The Ragunda Complex provides a looking glass into the mysterious processes during emplacement and may as such potentially provide quite unique geosites.

Subsequent to crystallization of the Ragunda Complex and associated rocks a regime of post-rift sagging created enough accommodation space to allow for the preservation of a sandstone unit on top of the granites. This unit is present in Finland and in the Nordingrå area, but very few outcrops are found in the Ragunda area. However, a sandstone filled fissure in the western part of the Ragunda complex is possibly a remnant of this sandstone unit. As a consequence of further stretching of the lithosphere, deep fissures opened and doleritic dykes intruded around 1200 million years ago. Some of them display weak columnar jointing which is caused by contraction of the magma during cooling[3].

[1] Kornfält, K.-A., 1997: Ragunda- och Mårdsjömassiven. I: Gorbatschev, R., Kornfält, K.-A. & Lundegårdh, P.H.: Beskrivning till berggrundskartan över Jämtlands län. Del 1: Urberget, 175-202. Sveriges geologiska undersökning Ca 53: 1.

[2] Persson, A.I. 1999: Absolute (U–Pb) and relative age determinations of intrusive rocks in the Ragunda rapakivi complex, central Sweden, Precambrian Research 95, 109–127

[3] Ahl, M., Andersson, U.B., Lundqvist, T. & Sundblad, K. (Eds.), 1997: Rapakivi granites and related rocks in central Sweden. Sveriges geologiska undersökning Ca 87, 99 pp.

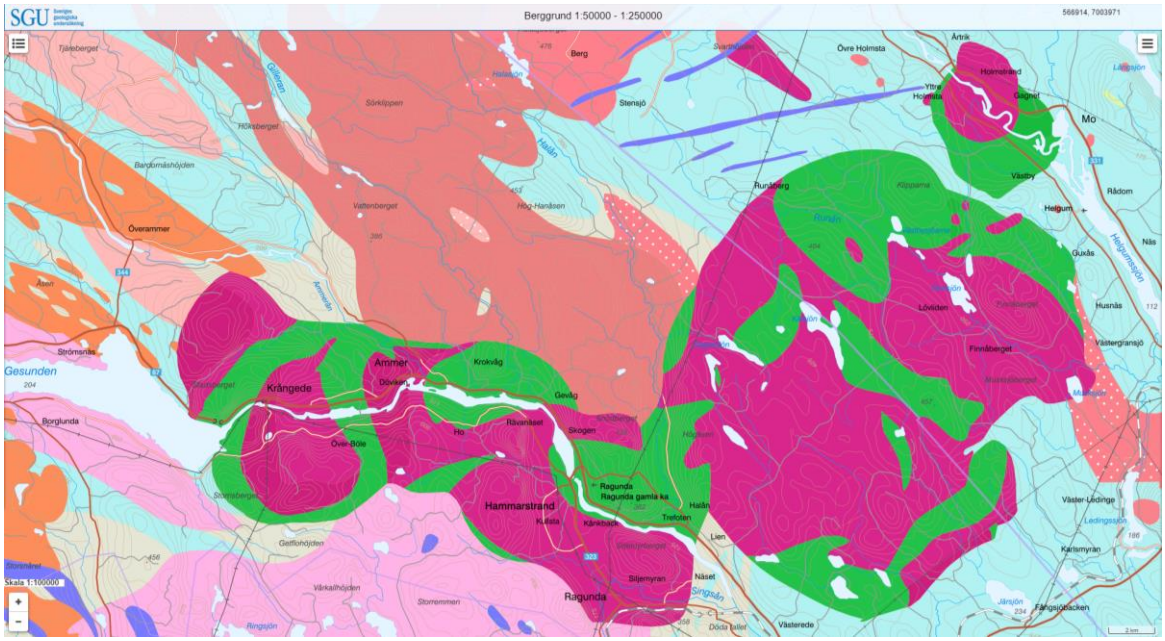

Figure 1. A simplified geological map of the area of interest. The Ragunda Complex in green and fuchsia colour and doleritic dykes in blue. All other rock types belong to the Svecokarelian Province. From the webbased mapservice at SGU.

3.2. QUATERNARY DEVELOPMENT

In the Ragunda area as well as in the majority of cratonic Scandinavia there are few geological remains at all between the Precambrian era and the Quaternary. The gap in geological remains is called a hiatus and in the case of the Ragunda area the hiatus represent about 1200 million years.

The Quaternary deposits in the area are rather complex. There is evidence of multiple glaciations in the form of repeated moraine deposits with interlayering glaciofluvial deposits[4].

The Indalsälven valley formed a narrow bay during deglaciation, especially in the Ancylus Lake stage. This means that deposits formed both under and above the highest coast line, adding to the diversity of Quaternary land forms and deposits[5].

[4] Carlzon [Caldenius] , C., 1913: Inlandsisens recession mellan Bispgården och Stugun i Indalsälfvens dalgång i Jämtland. GFF, 35-36.

[5] Lundqvist, J. 1969 Beskrivning till jordartskaratan över Jämtlands län.Sveriges Geologiska Undersökning, Ca 45, 1-423.

The area is also world renowned for the studies of ice-dammed lakes. There were several different ice lakes at different stages that were catastrophically tapped multiple times in the area. This is also the place where the important chronological tool of varve dating was developed, including the definition of the "Year Zero"[6]. Varve chronology is based on the process that there is a large difference between summer- and winter deposits in ice-dammed lakes. Thin, dark winter layers is in sharp contrast to thicker, lighter summer layers which reflect the sedimentation rate and availability of material from the glacier. The relative thickness of the layers are related to climatic indicators and therefore they may be correlated over a larger area and a very precise chronology may be established. The accidental man-made tapping of Lake Ragundasjön in 1796 exposed lake sediments from far back in time and made this area the perfect natural test-bed for developing this methodology.

Fig. 3. Extent of area below the highest coast line in brown. From Lundquist 1969.

[6] Borell, R. & 0fferberg, J., 1955: Geokronologiska undersökningar inom Indalsälvens dalgång mellan Bergeforsen och Ragunda. SGU, Ca 31.

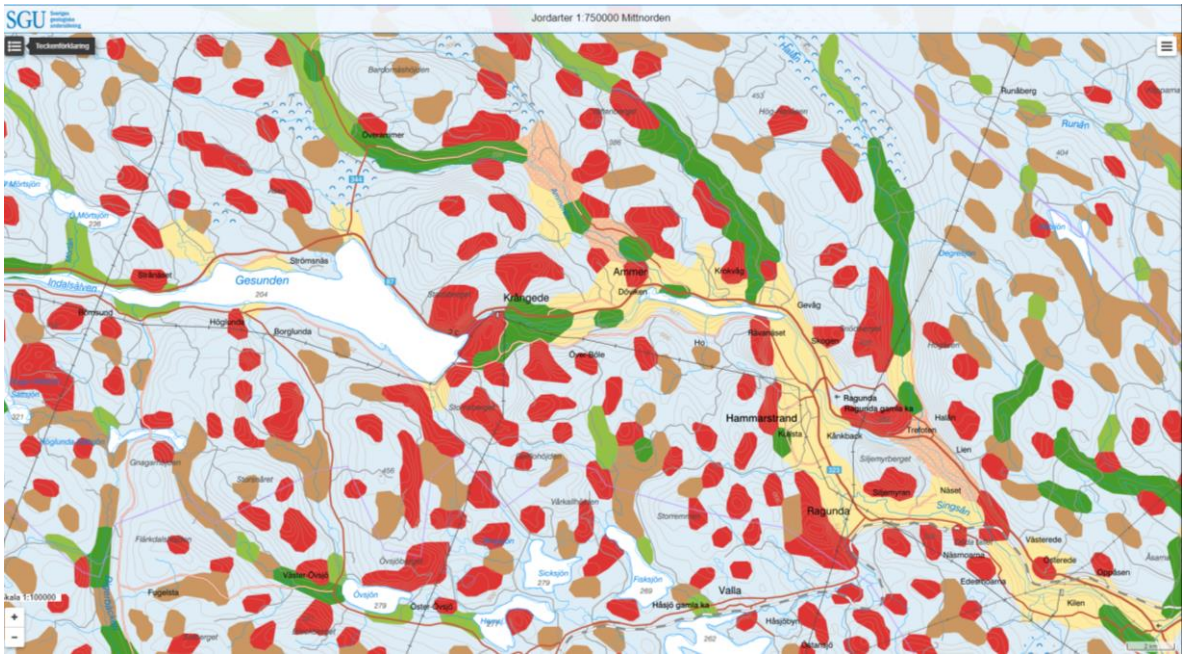

Fig. 2. Quaternary deposits in the Ragunda-Gesunden area. Colour represetations as follows: light blue- moraine, yellow- fluvial, green- glacifluvial, red- bare rock, brown- peat. From the webbased mapservice at SGU.

3.3. THE "HUSS EVENT"

In 1796 there was an accidental tapping of Lake Ragundasjön due to man-made weakening of a sandy barrier. The river Indalsälven catastrophically changed its course and the Lake Ragundasjön was more or less emptied in few hours. This is not really a geological event, but it had an impact on the geological heritage in several aspects.

Firstly, the former river bed and waterfall Storforsen was suddenly exposed yielding a pedagogic example of geological processes at work in a river environment in Döda Fallet.

Secondly, geological structures that was formerly hidden and/ or inaccessible due to the river was exposed, e.g. the beautiful examples of glacial potholes.

Thirdly, the flood wave created its own deposits of sand and gravel.

These considerations argue in favor of including the story of the disaster, making it a highly relevant contribution to the geological narrative[7].

[7] Wedholm, K., 1934: Ur Ragundadalens saga. - STF:s årsskr.

4. CONCLUSION AND INITIAL ASSESSMENT

The scope of this initial investigation was to evaluate the geology with reference to popularization and assess the potential of establishing a geopark in the area based on the geological heritage.

The area of interest is host to a quite remarkable geoheritage with a large geodiversity. There are remnants of many different aspects of geology, in everything from tectonic regime and age to the depth and speed of geological processes, but there will also be a large range in visual expression of different sites.

There will be sites that have geological values coupled with other values, such as biological, ecological, cultural, esthetic, pedagogic or historical. Or there may simply be the added value of a tickled fantasy or of a captivating adventure. This area is full of story-telling possibilities!

Many of the aspects of geology in the area have the added value that they connect to our understanding of the landscape itself, in a very hands-on manner. When geological processes are explained, so is the diversity and uniqueness of the landscape. This is often much easier to take in! If however, an interest is initially sparked a further discussion on for example magma chamber processes may feel so much more relevant.

Interestingly, there is an odd link between the unique Rapakivi-type granites and the varve geochronology, which both add to the unique quality of the area. This link is visual and come from the layers of lake sediments and the layers of feldspar precipitation in the granite, both ending up with a conspicuous striped or layered look (see front page), bearing witness that also small-scale changes in the geological system may have profound visual effects.

From the initial assessment of a small, but relevant collection of scientific papers and geological descriptions, it is my belief that a desirable number of geosites will be possible to define within the area and hence there is a fundament for initiating the preparation of an application for *Svensk Geopark* status.

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