

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement number: 642477



Project acronym: **iVAMOS!**

Project title: iViable Alternative Mine Operating System!

Funding Scheme: Collaborative project



Mine Site Visit Report – Vares

Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	<input checked="" type="checkbox"/>

Contents

LIST OF FIGURES.....	3
LIST OF ANNEXES	3
1 EXECUTIVE SUMMARY.....	4
2 INTRODUCTION AND OBJECTIVES.....	6
2.1 OVERVIEW OF VARES MINE SITE	6
3 TOPOGRAPHY, ACCESS AND EQUIPMENT LOCATION.....	8
3.1 GENERAL.....	8
3.1 ACCESS FOR VESSEL CONSTRUCTION	12
3.2 EQUIPMENT LOCATION.....	18
3.3 ENVIRONMENTAL FACTORS	21
4 APPENDIX.....	23
4.1 SLURRY CIRCUIT - DEWATERING FACILITY PARAMETERS	23

List of figures

Figure 1 –Map of Vares Mine Pit showing potential locations for equipment installation.....	5
Figure 2 - Vares Mine - Geology.....	6
Figure 3 –Vares Mine cross-section	7
Figure 4 –Vares Mine – dimensions of lake	8
Figure 5 –Vares Mine – waterfall at west end of lake	9
Figure 6 –Vares Mine – Landslip on south bank of open pit	9
Figure 7 –Vares Mine – Water outlet tunnel	10
Figure 8 Vares Mine - Open tunnel section Figure 9 Vares Mine - Looking North to pit.....	10
Figure 10 –Vares Mine – Tunnels to south of open pit.....	11
Figure 11 –Access to South bank of Vares mine from R444	12
Figure 12 –Access to South bank of Vares mine looking South East to R444.....	13
Figure 13 –Access to South bank of Vares mine looking North West in direction of open pit.....	13
Figure 14 –Flat area on approach to south beach that could be considered for a storage area	14
Figure 15 Approach to South Beach from minor fork in track (looking south)	14
Figure 16 Approach to South Beach from minor fork in track (looking north).....	15
Figure 17 - 'South Beach' - proposed site for mobilisation of equipment.....	15
Figure 18 - 'South Beach' - indication tight bend.....	16
Figure 19 - 'South Beach' - Possible new road and control cabin location.....	16
Figure 20 - 'South Beach' top view possible new road and control cabin location	17
Figure 21 - Proposed location for dewatering plant just south of 'South Beach' (photo).....	18
Figure 22 - Proposed location for dewatering plant just south of 'South Beach' (plan view)	19
Figure 23 - Panorama proposed location for dewatering plant	19
Figure 24 - Plan view showing possible location of anchors for vessel manoeuvring.....	20
Figure 25 - Temperature graph for Sarajevo (35km South of Vares) - Source 1	21
Figure 26 - Temperature graph for Sarajevo (35km South of Vares) - Source 2	22

List of Annexes

- Mine Site Data Collection (Vares)

(All separate annexes in pdf format)

1 Executive Summary

Vares Site was in operation from 1975 until 1990 and is a potential site for the VAMOS field trials. The open pit is approximately 800m long by 600m wide with a lake measuring approximately 620m from east to west and 316m from north to south.

The most practical access point to the pit is located on the south bank of the lake adjacent to an overflow tunnel. In this report this area is referred to as 'south beach'. The approach to this area is from the paved road R444 by a dirt track approximately 3.0m in width. From the road to South Beach is approximately 250 meters. The final approach to the edge of the water is quite steep at approximately 10 degrees. This area would require some civil engineering works to enable safe access to the water for the crane and for transporting equipment e.g. LARV sections, Generator, Mining Vehicle. An area adjacent to the water's edge would also require some work to make it level, and with a stable edge, and thus suitable for the crane. This should be investigated by a Civil Engineering contractor to assess the feasibility and cost of such works. After deployment of the LARV this area could be used to locate the control cabin, site office etc.

An area a short distance from the south of the mine pit was identified as a place where the dewatering facility could be located. This area would need to be cleared to produce a suitable area for the dewatering facility. This should be investigated by a Civil Engineering contractor to assess feasibility and cost.



Figure 1 –Map of Vares Mine Pit showing potential locations for equipment installation

A water sample for the purpose of measuring acidity was not taken from this site as there was no evidence of the water being acidic e.g. presence of aquatic plant life. The pH of the water has previously been measured at pH 8.7

2 Introduction and Objectives

The purpose of this visit to the Vares mine was to evaluate its suitability for use as a test site for the VAMOS mining system. Additional information is available in the 'Mine Site Data Collection' document. Amongst other things, this covers geology, past exploration works and ore characteristics.

This document covers the following topics:-

- Topography of site to determine if vessel and vehicle can be deployed safely
- Potential locations for dewatering facility and control cabin etc.

2.1 Overview of Vares Mine Site

Vares is an abandoned open pit iron mine that was under exploitation from 1975 until 1990. During the operation of the mine, the pit was kept dry by pumping the water out. With its reserves of more than 135 million t of iron ore, the mine was the largest in the former Yugoslavia. As a result of the mining, the width of the pit kept growing and reached 750m. In a relatively short period following the cessation of the mining activities, water flooded the mining pit and created a lake which is accumulated with storm and groundwater, dimensions 800 x 600 m and approx. 100 m deep. The lake is located along the route Vareš Majdan – Vareš, approximately 0.8 km southwest of the city center. The surface water of the lake drains via a tunnel and is then discharged into the Stavnja River approximately 500 m downstream of the Smreka River. Currently there are no economic activities in this mine.

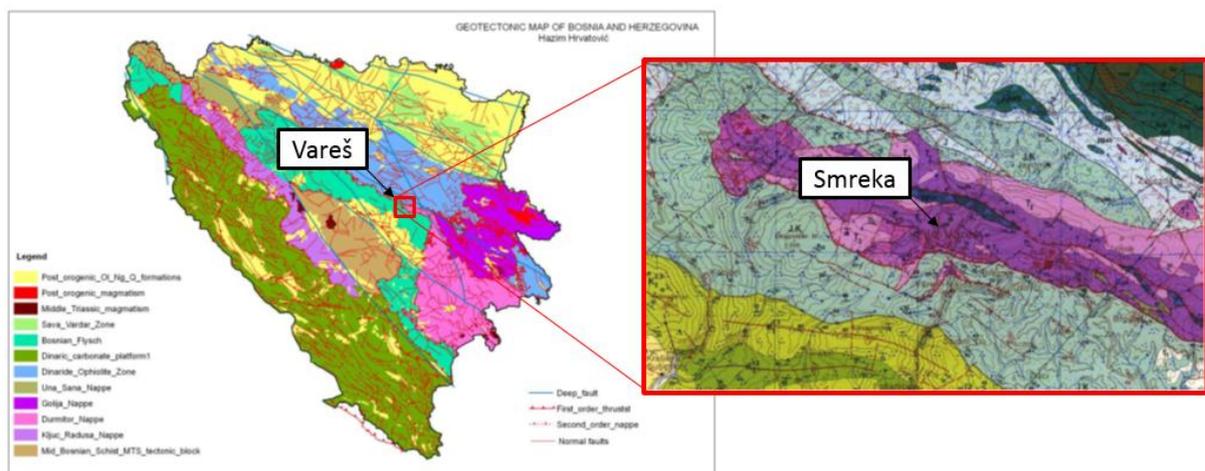


Figure 2 - Vares Mine - Geology

Type of mineral deposit:- Sedimentary exhalative deposit

Ore mineral:- Siderite, hematite, limonite, pyrite, marcasite, galena, sphalerite

Accessory minerals:- Mn-siderite, psilomelane

Bedrock:- Limestone

Age:- Middle triassic

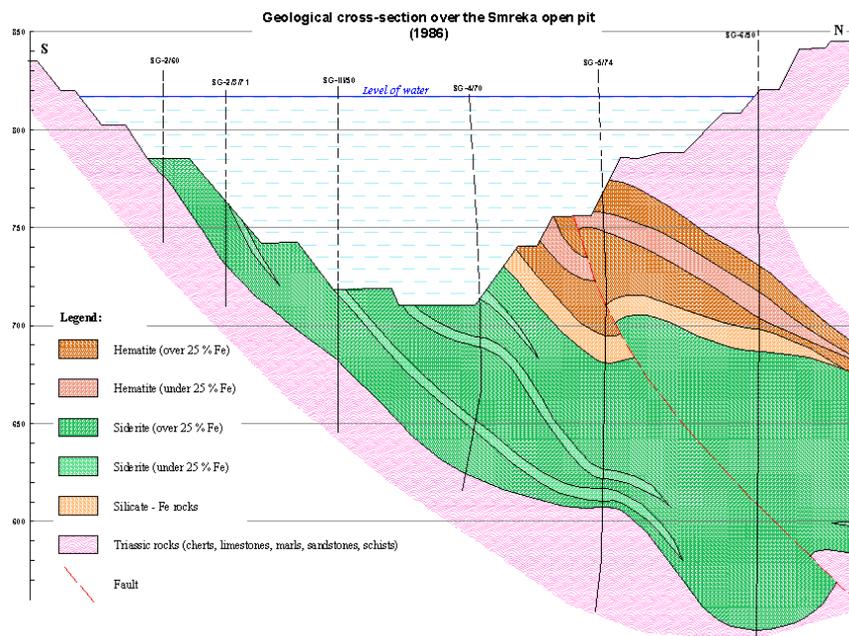


Figure 3 –Vares Mine cross-section

3 Topography, Access and Equipment Location

The mine site was evaluated to determine if access is acceptable for the field trials and possible locations for equipment were considered.

3.1 General

Location:

Latitude 44° 09' 14.4"N

Longitude 18° 19' 11.5" E

Altitude 829m

The open pit is approximately 800m long by 600m wide with a lake measuring approximately 620m from east to west and 316m from north to south.



Figure 4 –Vares Mine – dimensions of lake

The following observations of the site were made:-

- At the West extent of the open pit a small waterfall was observed at the time of the visit.
- Evidence of a major landslip was observed on the slope at the south bank of the open pit.
- A tunnel at the South East extent of the lake provides an outlet for the water in the lake and provides a limit for the maximum level of the water. The tunnel is in a poor state of repair, and is partly open to the surface. The water flowing through this channel is limited and according to local people, there is hardly any variation in pit water level.
- An entrance to a second tunnel was found to the south of the open pit. This appears to be connected to the lake as water was present a short distance inside the tunnel at approximately the same level as the water in the lake. However it is unknown what its function is, or where it leads to.



Figure 5 –Vares Mine – waterfall at west end of lake



Figure 6 –Vares Mine – Landslip on south bank of open pit

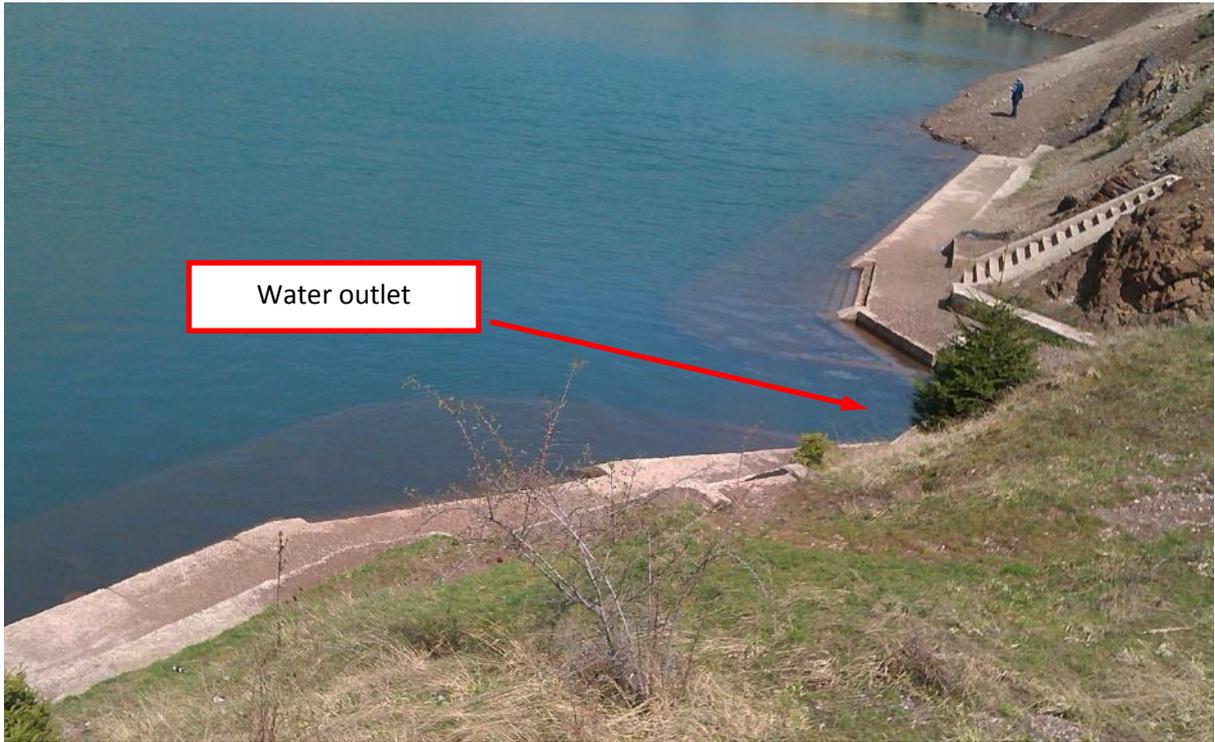


Figure 7 –Vares Mine – Water outlet tunnel



Figure 8 Vares Mine - Open tunnel section



Figure 9 Vares Mine - Looking North to pit



Figure 10 –Vares Mine – Tunnels to south of open pit

3.1 Access for Vessel Construction

The most practical access point to the pit is located on the south bank of the lake adjacent to an overflow tunnel. Throughout the rest of this report this area will be referred to as South Beach. A track leaves the paved road R444 just south of the pit and approaches this area via a dirt track approximately 3.0m wide. This track continues with one last tight bend with a diameter of 10 meters. The final approach to the edge of the water is quite steep at approximately 10 degrees. This area would require some civil engineering works to enable safe access to the water for the crane and for transporting equipment e.g. LARV sections, Generator, Mining Vehicle. An area adjacent to the water's edge would also require some work to make it level, and with a stable edge, and thus suitable for the crane. From the road to South Beach is approximately 250 meters. The flat area at South Beach could be enlarged to create an area 25 x 20 meters to accommodate a crane for deployment and later on the control cabin. Prior to any work done at South Beach its dimension were approximately 20 x 15 meters.

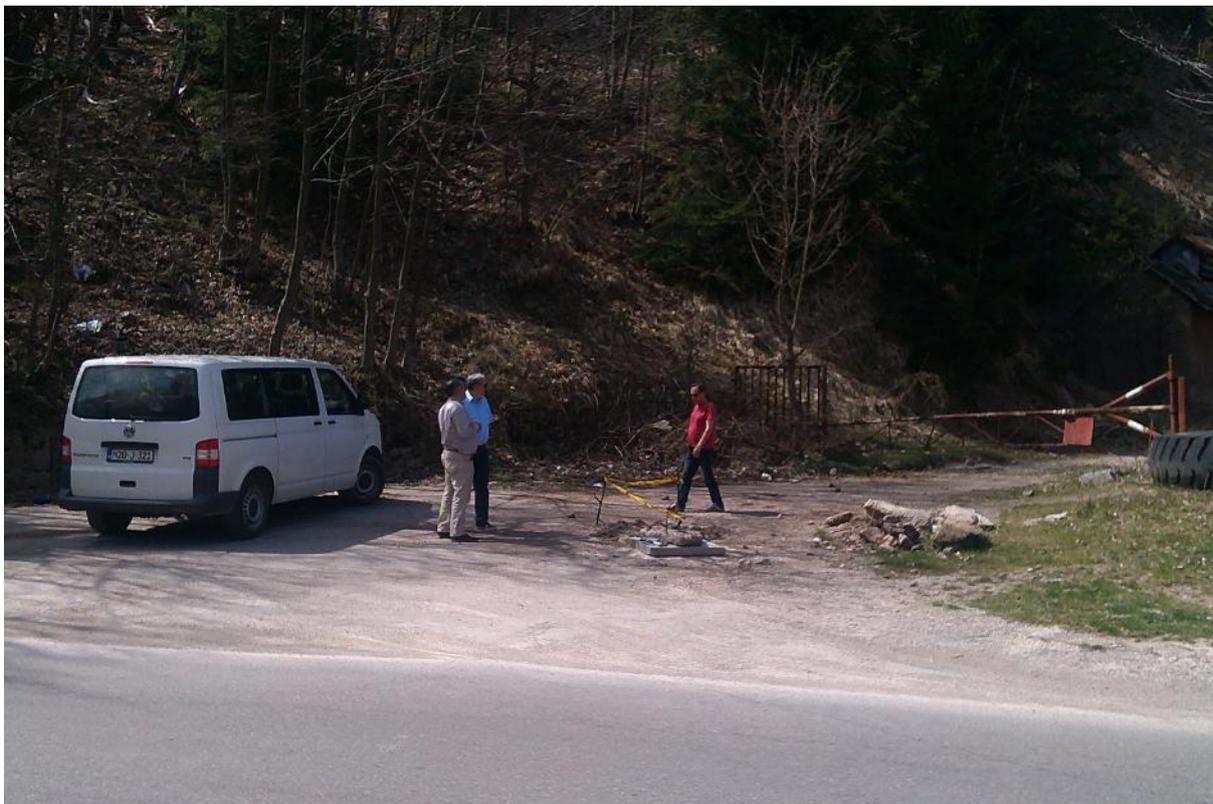


Figure 11 –Access to South bank of Vares mine from R444

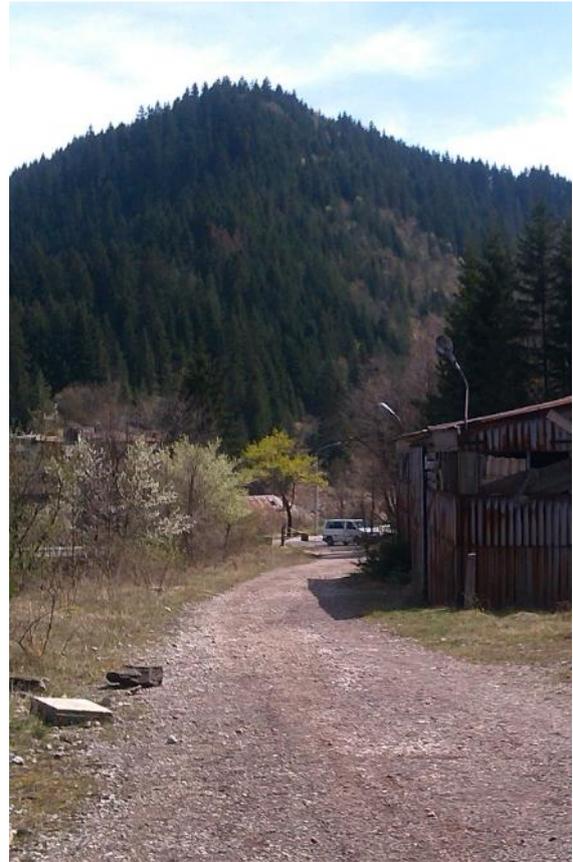


Figure 12 –Access to South bank of Vares mine looking South East to R444



Figure 13 –Access to South bank of Vares mine looking North West in direction of open pit



Figure 14 –Flat area on approach to south beach that could be considered for a storage area



Figure 15 Approach to South Beach from minor fork in track (looking south)



Figure 16 Approach to South Beach from minor fork in track (looking north)



Figure 17 - 'South Beach' - proposed site for mobilisation of equipment



Figure 18 - 'South Beach' - indication tight bend



Figure 19 - 'South Beach' - Possible new road and control cabin location



Figure 20 - 'South Beach' top view possible new road and control cabin location

3.2 Equipment Location

The area around the mine is not especially steep but is very overgrown. Equipment would best be located close to the mine pit, referred to as 'South Beach' area. A suitable area would need to be cleared and levelled to accommodate the site office, control cabin, welfare facilities etc. This could be the same area as that used for the construction of the Launch and Recovery Vessel. Close to this area is a large area at a slightly higher elevation than the water level that could be used for the dewatering plant, the elevation is estimated to be 15 meters.

From the slurry circuit specification the area required for the dewatering facility is estimated at approximately 4800m² with a 0.8m layer thickness. Measurements made were approximately 40 x 20 m. With a theoretical layer thickness of 1 m we would require roughly 3200 m². Currently the area contains heaps of debris from demolished buildings. This debris needs to be partly removed to create a depositing space of 65 x 50 m. One of the already existing tunnels could be used to feed back the water from the deposit through a hose.

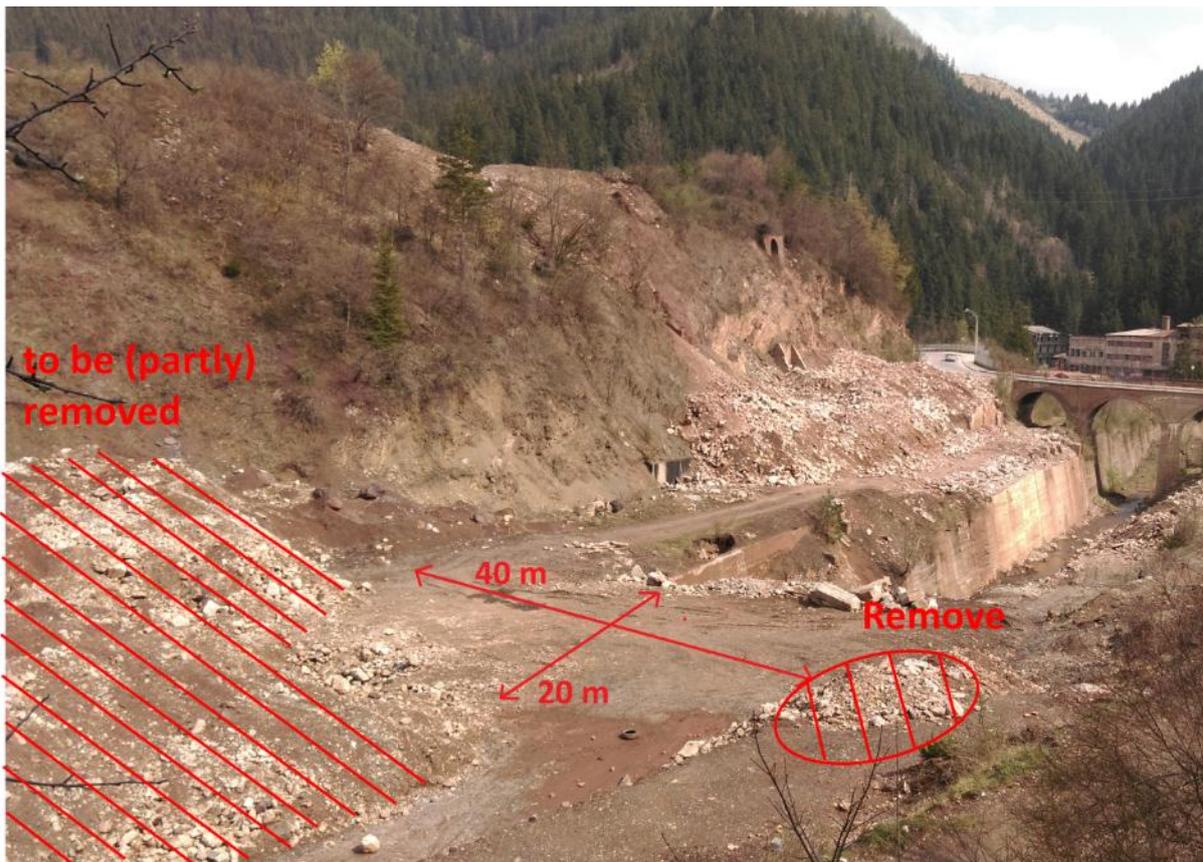


Figure 21 - Proposed location for dewatering plant just south of 'South Beach' (photo)



Figure 24 - Plan view showing possible location of anchors for vessel manoeuvring

Note: The quays at the tunnel entrance may be used as a jetty for the tender boat.

3.3 Environmental Factors

Environmental conditions such as temperature and precipitation must be considered for the test site. The graph below shows the temperature and precipitation for Sarajevo which is 35km South of Vares (50km approx. by road). Vares is approximately 829m above sea level and Sarajevo 518m. There will inevitably be differences in temperature due to local weather patterns, but the information below should be enough to highlight any concerns due to extreme seasonal changes.

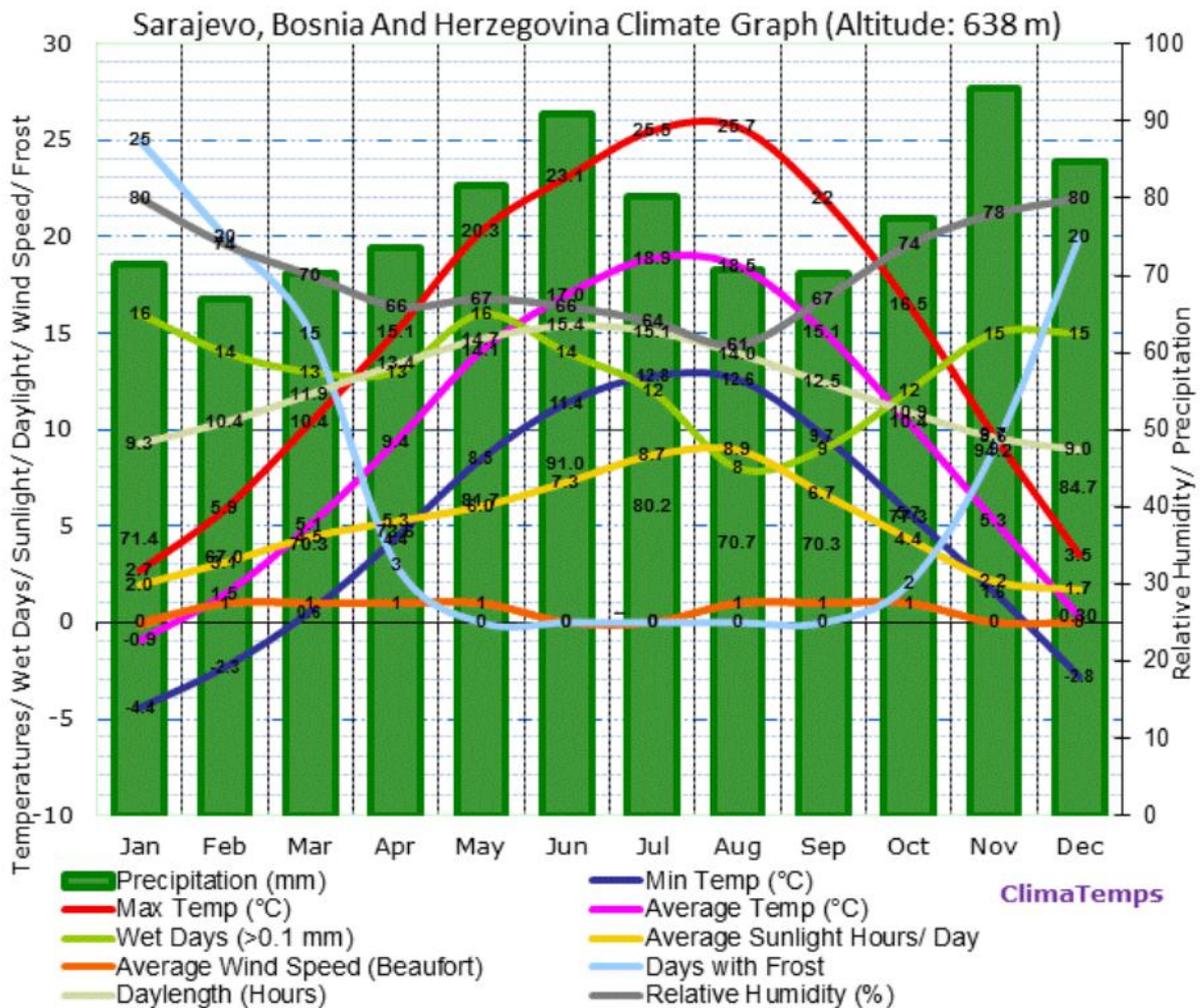


Figure 25 - Temperature graph for Sarajevo (35km South of Vares) - Source 1

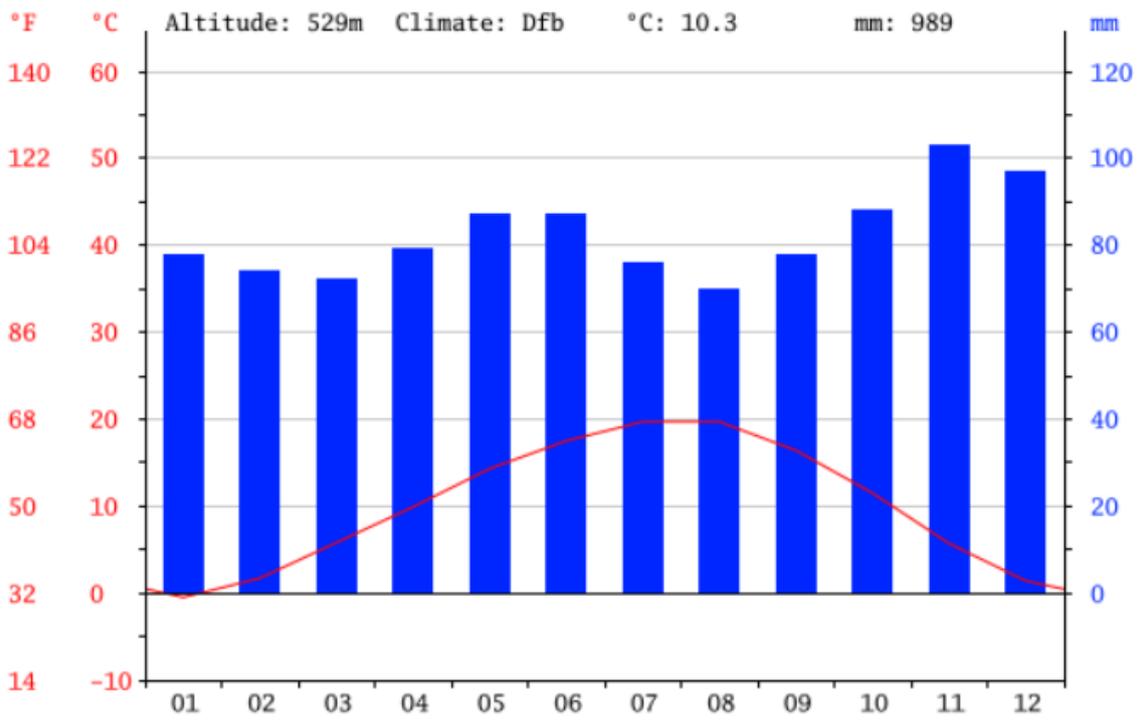


Figure 26 - Temperature graph for Sarajevo (35km South of Vares) - Source 2

Sources:

- 1) <http://www.bosnia.climateemps.com/>
- 2) <http://en.climate-data.org/country/244/>

4 APPENDIX

4.1 Slurry Circuit - Dewatering facility parameters

Extract from D2.3: Slurry Circuit System Specification (page 47):-

Technical specification

Ore production	60	m ³ /h
Mixture production	386	m ³ /h
Transport concentration	15.54404	%
Transport water	326	m ³ /h
Daily production	480	m ³ /h
Total production	1920	m ³
Settling layer	0.4	m
Area	4800	m ²
Width	69.28203	m
Length	69.28203	m