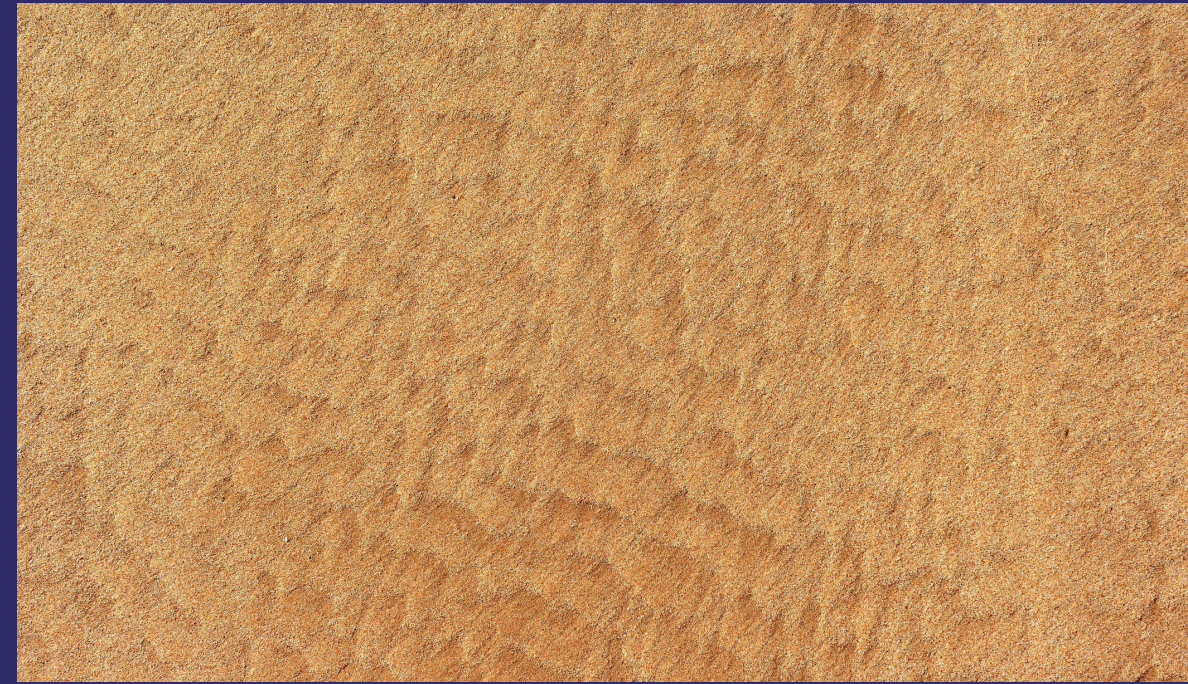


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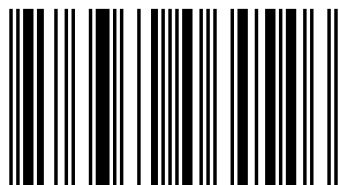


Avtandil Okrostsvaridze



Avtandil Okrostsvaridze graduated from Tbilisi State University. At present he is a professor of geology at Ilia state University, Georgia. His main scientific interests comprise: magmatism of orogenic systems and ore mineralization processes related to them. He has published over seventy articles in refereed scientific journals and five books.

The Argonauts: A Modern Investigation of the Mythical "Gold Sands"



978-3-330-06454-6

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Impressum / Imprint

Bibliografische Information der Deutschen Nationalbibliothek: Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über <http://dnb.d-nb.de> abrufbar.

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Bibliographic information published by the Deutsche Nationalbibliothek: The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

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Coverbild / Cover image: www.ingimage.com

Verlag / Publisher:

LAP LAMBERT Academic Publishing

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OmniScriptum GmbH & Co. KG

Bahnhofstraße 28, 66111 Saarbrücken, Deutschland / Germany

Email: info@omniscryptum.com

Herstellung: siehe letzte Seite /

Printed at: see last page

ISBN: 978-3-330-06454-6

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Foreword

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This strong belief of mine, which is not based on romantic feelings however, but rather on the findings of multidisciplinary, fundamental study, I want to share with others and that is why I decided to write and publish this book.

ACKNOWLEDGMENTS

Many people have contributed directly or indirectly to the writing and production of this book, I would like to thank all of them.

First of all, many thanks to my family bravely standing by me during my long expeditions and always supporting me in my scientific activities.

I would like to thank Dr. Mustafa Mutlu, General Director of the "Golden Fleece" mining corporation, who has funded this research. Many thanks to my colleagues and friends Eteri Kilasonia, David Bluashvili, Nona Gagnidze and my students George Boichenko and Iulia Bobrova for the cooperation and the assistance they have rendered in making this book.

My thanks and liking to the residents of Svaneti region, for the valuable assistance they rendered during this work. Special thanks to Mr. Robert G. Blair – economist geologist (USA), for his valuable advices and comments. I am thankful to Mr. Nicholas Kilasonia for all his support I received in the translation of the English version of this book.

And finally, I would like to thank **LAMBERT Academic Publishing**, which gave me a chance to share my ideas and thought with the international readers.

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Introduction

The legend of the heroic quest of **Argonauts** is one of the oldest and widely known myths of our civilization and the **Golden Fleece** is probably the most enigmatic phenomenon. For more than 2000 years already, an enormous volume of scientific research and pieces of art has been dedicated to this legend, with little to no truly reliable information found so far, though.

The topic has been and is still being studied by historians, archaeologists and writers, but no one has yet studied it from geological point of view. In the meantime, the geological argumentation may well prove crucial, as far as, if the Argonauts voyage has really happened and if the **Golden Fleece** is somehow linked to the gold mining technology, that might mean that the Argonauts have carried out one of the first geological expeditions in the history of our civilization. That is why, we thought worth examining this ancient scientific dispute from the geological perspective too.

For this reason we decided to carry out this unusual geological research, carefully comparing the conclusions with the extant historical and archaeological data. Need to underscore here, that recently, with advent of the modern technologies; the efficacy of the geological research has increased dramatically, making the findings way more reliable. In our research, we have used the latest methods of the sample chemical analysis, more specifically, Inductively Coupled Plasma Mass Spectroscopy (ICP-MS), Remote Sensing of the Chemical Content of Bedrock and Placers (Aster Mineral Alteration Mapping), Radiometric Dating (U-Pb dating of zircons by LA-ICP-MS), Electronic Microscope Scanning of Gold particles, etc. Apart from the obtained geological information, we have built upon the extant data on the **Santorin Island** catastrophe in **Aegean Sea** near the **Crete**, radiometric dating of the eruption consequences, in particular. Beside the geological data, we have worked with the Greek and Roman ample written sources regarding the ancient **Kingdom of Colchis** and also obtained some fresh archaeological and ethnographic data on **Svaneti** and matching up these all enabled us to judge upon the probability of Argonauts real

voyage to the **Kingdom of Colchis**, the findings whereof we offer in the present book.

In order to form our own opinion, we decided to study the territory of the ancient **Colchis** kingdom geologically, in order to find the areas where mining gold from alluvial placers could have taken place i.e. a place where the Argonauts could have extracted gold and come to know the ancient mining technologies of this particular region. For this purpose, our group has carried research for more than 20 years in the western part of the Republic of **Georgia**, around the regions of **Abkhazia**, **Samegrelo**, **Imereti**, **Svaneti**, **Racha**, **Guria** and **Adjara**. Our work has confirmed that **Svaneti** is a region, uniquely, where the locals still wash gold from alluvial placers through modern domestic, wooden vessels or pans with holes in the bottom and onto a sheepskin or a fleece, which collects the fine particulate gold; where it is still possible to wash gold from the sand placers; where one can still find archaeological artifacts and ethnographical information about the **Golden Fleece**.

From what we were able to conclude after matching our geological findings with the existing Greek and Roman written sources, the voyage of Argonauts, a small team of Greek mythological heroes to the ancient **Kingdom of Colchis** appears to have really happened. It is highly probable that the voyage has taken place before the eruption of the **Santorin** volcano, between 1570-1580 BC, since Argonauts represented the Minoan civilization and were in the least likely to be capable of carrying out an expedition of this scale after the disaster. We assert that the main purpose of this mission was to obtain gold and gold mining technology from those who were working along the river sands of the **Kingdom of Colchis**. As for the **Golden Fleece** phenomenon, according to our research, it is connected with the sheepskin (fleece) technique of gold recovering, which later on resulted in formation of the romantic concept of the **Golden Fleece**, that has existed in the civilized world ever since **Homer's** time.

Theme of Argonauts in the Antique Greek writing

The theme of the Argonauts campaign to the kingdom of Colchis has been a source of inspiration for the Antique Greek Writing from *the Odyssey* by **Homer (VIII cc, BC)** to *The Argonautica* by **Apollonius of Rhodes (III cc, BC)**. Perhaps, only the legend of the Trojan Wars could compare with the Argonauts. The great **Homer** touches upon this theme in his *Odyssey* on several occasions, saying that the Argonauts have journeyed to the kingdom of Colchis long before the Trojan wars. **Hesiod (VIII cc, BC)** speaks about Argonauts in his *Theogony*, saying that they sailed to the **river Phasis** (modern-day **r. Rioni**). Following **Hesiod, Eumelus of Corinth (VII cc BC)**, a Greek poet, mentions Argonauts in his *Corinthiaca*. It should be noted, that in general, pretty much all Greek poets of antiquity have mentioned Argonauts, however, in its entirety, the story of Argonauts has been narrated by **Pindar of Thebes** in his *The Epinica* (VI -V cc BC).

As for **Aeschylus (525 - 456 BC)**, a founder of the Greek tragedy, he has widely used the fragments of the Argonauts tale in his *Oresteia*, a renowned trilogy. Tradition has it, that apart from this, **Aeschylus** should have had written a trilogy about Argonauts: *The Argo*, *The Hypsipyle*, and *The Cabeiroi*, as well as the tragedies: *The Phineus* and *The Lemnian Women*. Another legend says that **Sophocles (597-406 BC)** has written about the Argonauts in his *Lemniai*, *The Blind Phineas*, *The Colchians*, *The Scythians* and *Pelias*. Unfortunately, none of the plays have reached our time. From the tragedies written about the Argonauts only *Medea*, a tragedy by **Euripides** has survived, a plot of which turns around the horrible vengeance by *Medea*.

The most of the extant fragments and also a footnote reference from *Argonautica*, a poem by **Apollonius of Rhodes**, prove that the theme of Argonauts has been touched upon by **Hecataeus of Miletus, Skilak of Kariand** and other writers. The poem several times mentions **Herodorus of Heracles**, a predecessor of **Herodotus**, as the author of a prosaic version of *Argonautica*. **Herodotus (484 - 425 BC)**, dubbed the

father of history, has no mention of the Argonauts in his *Histories*, but writes about the **Colchians** as of the descendants of the ancient **Egyptians**.

The first complete, fundamental work on the Argonauts theme is the *Argonautica* by **Apollonius of Rhodes** (295 - 215 BC), that tells the whole story of the Argonauts adventure in **Colchis** in a poetic way, from the very outset of the voyage at the port of Yolkos, all the way down to the **Aya** (the modern-day city of **Kutaisi** in **Georgia**) and back to Thessaly, together with the precious trophy of the **Golden Fleece**. Besides, in this source, for the first time in the Antique Greek writing had been provided more or less complete information about the **Kingdom of Colchis**. The poem describes the country and the inhabitants thereof, mentions the ethnographic and geographic place names of **Colchis** - invaluable information for the historians of this country.

This is a short review of the ancient Greek writings on the Argonauts theme. However, the list is so long that it is impossible to discuss it here in full. For the purposes of our research, we have no interest in the artistic value thereof, the most important being that the majority of the writings speak of the Argonauts voyage as of a true story, a historical event. In addition, *The Odyssey* by **Homer** asserts that the Argonauts have traveled to Colchis much earlier than the **Trojan Wars** happened, which is a very important fact for our research.

The Argonauts' trip: A Myth or Reality?

As is known, the ancient Greeks believed that the universe was ruled by immortal and powerful gods which designed the lives of the mortals. That is why, Greeks have been inventing numerous legends and myths, that blended later with many historical events that have really taken place in the history and vice versa - true historical events formed the plots of legends and myths. Because of this, scholars often base upon the myths and legends in their research of the ancient Greek civilization.

The Greek tale of the Argonauts heroic voyage has been one of the oldest and famous legends of our civilization. According to one of the versions of this myth, **Hermes** sent **Hera** a golden ram by an order from **Zeus** himself. **Phrixus** and **Helle**, children of the king **Athamas**, flew to Asia on the ram's back, to escape from **Ino**, their stepmother. **Helle** fell into the sea on the way and draw ned, while **Phrixus** reached the **kingdom of Colchis** and sacrificed the ram to **Zeus**, gifting the golden sheepskin to **Aeëtes**, king of **Colchis**. The golden sheepskin (known as the **Golden Fleece** afterwards), became henceforth a symbol of prosperity of **Colchians** and was guarded by dragon in the **holy grove of Ares**.

Pelias, king of **Thessaly**, promised his throne to **Jason**, his nephew in exchange to the **Golden Fleece** from **Colchis**. Having accepted the offer, **Jason** ordered **Argus**, a shipbuilder, to build a ship, having named the ship **Argo** and the crew - the **Argonauts**, accordingly. Then, **Jason** convoked a 50-person team of selected warriors of **Hellas** and set out from the port of **Iolkos** in the quest of the **Golden Fleece**. After a long voyage full of hazards, the Argonauts finally reached the **Pontos Euxeinos (the Black Sea)**, sailed up the river **Phasis** (r. Rioni) and arrived in **Kutaia** (city of **Kutaisi** in the modern-day **Georgia**), a fortress of **Aeëtes**.

Aeëtes assigned **Jason** to the hardest tasks in exchange to the **Golden Fleece**, which **Jason** managed to successfully fulfill with the help of **Medea**, a charming magician daughter of **Aeëtes**, as she fell in love with the Greek prince. Having received the

Golden Fleece as was promised, **Jason** returned to Greece together with **Medea** and married her. Soon Jason cheated on **Medea** and left her to marry a daughter of **Creon**, king of Corinth. **Medea** took a horrible vengeance on **Jason**, having poisoned King **Creon** and his daughter first and hiding away her and **Jason's** children in **Hera's** temple. She murdered them in another narrative. This is a very brief content of one of the versions.

The story is a **Mycenaean** myth, generated before the time of the **Trojan War**, around 1500 BC, but the first known written mention of it comes six centuries later, in the age of **Homer** (VIII BC). The tale came out of the region of **Thessaly**, in **Greece**, where early epic poetry developed. The Greeks have retold and reinterpreted it many times since, changing it as their knowledge of the physical world increased (Wood, 2011). No one knows for sure, where the earliest poets set the adventure, but by 700 BC, a poet **Eumelos** set the tale of the **Golden Fleece** in the **Kingdom of Aia**, a land that at the time was thought to be an eastern edge of the world. At this point, the Jason story becomes fixed as an expedition to the **Black Sea**. The most famous version, penned by **Apollonius of Rhodes**, head of the library at Alexandria, was composed in the third century BC, after the invasion of Asia by **Alexander the Great**.

Is it a myth or a reality? The myth of the Argonauts trip to the ancient **Kingdom of Colchis** in the quest of the **Golden Fleece** has always been one of the controversial issues in the historical science. There are many contradictory legends and opinions about this mythical journey. The trip has been told as a real story by **Homer** in his classic poem *The Odyssey* (VIII c. BC), as was in a play *Medea* by **Euripides** (V c. BC). Greek poet **Apollonius of Rhodes** dedicated a poem *Argonautica* to this voyage in the III century BC. In the poem, **Apollonius** gives a detailed description of the **kingdom of Colchis**, the capital city – **Aia** (modern **Kutaisi**) and the **Georgian** tribes **Khalibi**, **Tibarenni** and **Mosinici** (Race, 2008). It is believed that **Aeëtes** reigned in **Colchis** at the time of **Jason's** journey. Tales about **Medea**, a daughter of

Acētes, a sorceress, were known beyond her kingdom, as was the fame of her country's gold, silver and iron. Quite credible, that this has been a leading motivation of the Argonauts' expedition. Mountain Rivers of **Svaneti**, a province of **Colchis**, have been carrying down gold-bearing gravel, which has been washed in special pans with punched holes and carefully strained through sheepskins under the pans. Some believe that the fame of the fabulous wealth of the **Kingdom of Colchis** and the treasures of its Kings have excited the enterprising avarice of the Argonauts.

The routes Argonauts travelled to **Colchis** and back to **Greece** is still a subject of dispute among the scholars. As what we know about the journey comes from poets for the most part, seems that the narrative has been largely embellished. There are several versions of the route, albeit the way from Greece to Colchis seems to be the same pretty much everywhere: **Iolkos-Lemnos-Heraclea – Colchis**. By contrast, the return route has been subject to rather confusing interpretations, largely due to the changing Greek understanding of geography as well as the complications caused by efforts to map a myth born in the age of ignorance onto the real terrain, which rarely matches the vision of the ancient bards. Below we offer two versions of the routes, that are most shared by the scholars. The first one is the route described by **Apollonius of Rhodes** in *Argonautica* (see. fig.1), according to which, Argonauts have crossed the **Black Sea** from **Colchis** to the river **Danube**, entered the mainland **Europe** and returned to **Greece** by a complicated route.

In the last century, the return route of the Argonauts has been staying a topical issue. In 1984, **Tim Severin**, a British scientist, in a **Modern Argo**, a boat of his, followed the same route the legendary **Jason** has travelled more than three thousand years ago. **Tim Severin** and his crew of "New Argonauts" sailed from the city of **Volosi** in the **Aegean Sea**, to the **Black Sea** and reached city of **Poti** in **Georgia** (the ancient **Phasis**) on the east coast of the **Black sea**. **Tim Severin** has proved with this voyage, that thanks to outstanding skills and sturdy vessels, the ancient Greek sailors could have easily reached the **Kingdom of Colchis** (**Severin, 1984**).



Fig. 1. Route of the Argonauts according to Apollonius of Rhodes (after J. Colavito, 2014).

Since the voyage has shown that the wooden boats of antique Greeks were easily capable of sailing from the Adriatic to the Black sea, the question of feasibility of the Argonauts trip from this standpoint has been effectively withdrawn. Further, we'll try to assess the probability, objective and timeframe of this event on the basis of geological argumentation.

We'd like to add in the end of this chapter, that since the legend of the Argonauts feat has been so very much enchanting and intriguing for more than two thousand years, there is hardly an area left in the history and art of Europe, where the theme of **Jason** and the **Argonauts**, the **Golden Fleece** and the sorceress **Medea** have not had at least a modest impact.



Fig. 2. Route of the Argonauts according to Herodorus of Heracles (after J. Colavito, 2014).

One of the good examples is a **Terracotta Campana** relief **Athena supervises the building of the ship "Argo"** for the expedition of Jason and the Argonauts exhibited in the British Museum, London (Fig. 3), as are numerous other pieces of art scattered across the globe. We think that this dedication to the theme, so long and so deep, as it has been from the European art to Argonauts, speaks in favor of the journey being more a real event, rather than a myth. We should repeat here, that the theme is still relevant in the modern historic science (Hunter, 1998; Slavitt, 1999; Wood, 2011; Nelson et al., 2015) and still attracts a strong attention of the society.

In the chapters that follow, we'll try to show, that what has been verbally conveyed or written about the gold bearing placers, probably the main target of Argonauts, is quite real and not a figment of the imagination. It is real that the locals have been mining gold with use of wooden wash pans and sheepskins. Besides, in the areas where the gold bearing placers are, the excavations in the villages have unearthed numerous stylized bronze artifacts depicting fragments of the Golden Fleece legend. This too speaks in support of the hypothesis that the Argonauts may have existed in reality.



Fig. 3. Athena supervises building of the 'Argo'. Roman bust (bronze), 1st-2nd century AD. Terra-cotta relief of British Museum, London.

Very long time has gone since the Argonauts, more than 3500 years, to be more specific. The history is very forgetful in the meantime. The catastrophe of Vesuvius is probably the best example: on August 24, of the year 79 AD, **Pompey** and **Herculaneum**, the two flourishing towns of the **Roman Empire** were buried under the ashes and pyroclastic mass, just to be forgotten for almost 1700 years and rediscovered only in the early 18-th century, by a mere accident, in the course of some construction works. Finally, **Henry Schliemann** has proved **Homer** was writing truth, with his discovery of **Troy** and **Mycenae**. Why can't we trust the great **Homer** then with his tale of the **Argonauts**?

The Golden Fleece: a symbol of wealth or a gold imprinted sheepskin?

As we know, the main goal of **Jason** and the **Argonauts**, according to the myth, was to grab the **Golden Fleece** from **Colchis** and get back to **Thessaly** with it. Even though, the **Golden Fleece** is a central object of the myth, there is nothing there to give a hint of what it really was, which has given birth to a host of different versions and interpretations. The **Golden Fleece** theme is widely displayed in the ancient art with the myth scenes shown in the drawings, on the excavated amphora (Fig. 4) and the bas-reliefs on the tombs (Fig.5). From the antique times till present, scientists have been keen to define the phenomenon of the **Golden Fleece** more or less precisely - to no avail, so far.

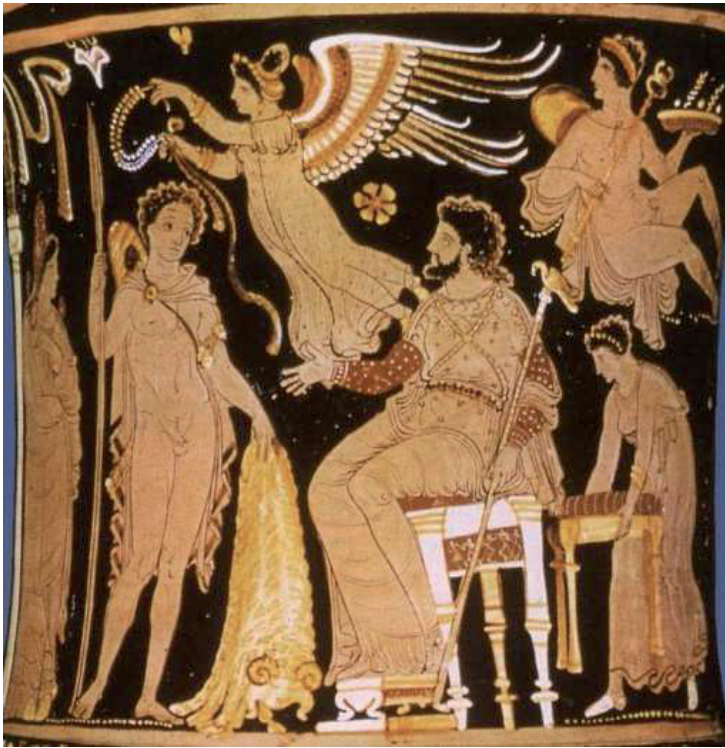


Fig. 4. Jason returns with the Golden Fleece, shown on an Apulia red figure calyx craters, ca 340-330 BC.



Fig. 5. Jason seizing the Golden Fleece. Fragments of a sarcophagus. Luni marble, Roman artwork, second half of the 2nd century AD.

The versions that are trying to explain the phenomenon in the modern science, are grouped in about 20 directions. Among these, in our opinion, the most relevant are the following: 1. A gold extraction technology from gold bearing placers (**Strabo**, book-XII; Pliny the Elder I c. AD; **Appian of Alexandria** I-II c. AD; Tran, 1992, and others); 2. A symbol of power of the Kingdom (Braund, 1994; Lordkipanidze, 2001; Newman, 2001, and others); 3. A symbol of wealth and high technologies of **Colchis** (Urushadze, 1964, 1984); 4. A special breed of sheep (Ryder, 1991; Smith G. J. Smith A.J, 1992, and others).

The oldest of the hypothesis is probably the one that thought of the Golden Fleece as of a gold recovery technology from the gold bearing placers with the use of sheepskin. It is thought that, in the process, heavy gold particles got stuck in the

dense wool, giving the fleece a golden hue. Through this, the **Golden Fleece** acquired an artistic image of a gold colored sheepskin and has further been diversely interpreted by different artists. That is exactly the stylized artistic image, the **Golden Fleece** has had in the antiquity and still retains. We think that this is a correct interpretation of the legendary phenomenon. The theorists used to see the **Golden Fleece** as a symbol of wealth of **Colchis**, which has been famed since antiquity for its treasures. It is believed that **Aeëtes** reigned in **Colchis** at the time of **Jason's** journey.

The third version is close to the first one in its content and was born during the European Renaissance, as soon as the knight's era came to the end. The two versions can be grouped together. The fourth version hypothesizes that the **Golden Fleece** could have been a particular species of the sheep, with a special kind of wool. The idea, that the fine wool might well have been given the epithet of golden, because of its value, is not unreasonable at all, given that sheepskins were used to collect gold particles from streams. That the fleece was yellow is unlikely since such discoloration is a wool fault, but it is just possible that "golden" might refer to genetically "tan" fiber (Rider, 1991). We think that this version is unfounded and cannot be seriously considered, therefore. Yet, it undoubtedly is a completely new vision of the **Golden Fleece** concept.

The original meaning of the **Golden Fleece**, in the long course of the European history, became gradually hidden in a shroud of romance and mystery. The concept acquired a meaning so sacred, that discrete orders of **Golden Fleece** started to spring up in the medieval Europe, as symbols of power and wealth of kingdoms. The first **order of Golden Fleece** was founded in Bruges by **Philip III the Good**, Duke of Burgundy in 1430, to celebrate his marriage to the Portuguese princess **Infanta Isabella of Portugal**, daughter of **King John I of Portugal**. Later it became one of the most prestigious orders in Europe.

Later, the **orders of Golden Fleece** were founded by **Spanish Habsburg** royal house (1700) and **Austrian Habsburgs** (1740). The choice of the Golden Fleece of Georgian Kingdom of Colchis as the symbol of a Christian order caused some controversy. Despite all this, the **order of the Golden Fleece** is still one of the oldest and most honorable orders of **Europe** and is still worn by Spanish and Austrian royal entities. Importantly, all these decorations bear the appearance of a golden ram skin.



Fig. 6. Various versions of the Golden Fleece order of Austrian Habsburgs royal house.

The rest of the world still respects the Golden Fleece and the decoration is often used as a national award, as well as an award for winners of various cultural events. **Georgia**, for example, has established a **Golden Fleece award** in 1998 and now it is awarded for special merits before the nation. There is a **Golden Fleece award** in **Ireland**, which is given to the most gifted people of arts.

Despite a flood of new information in the modern time, the **Golden Fleece** concept is still disputable. From what we could see in the course of our research, we think that the **Golden Fleece** bears in the myth a symbolic meaning of technology for mining gold from the gold placers along the river banks. In antiquity it was a myth; during the early Middle Ages - in the time of knights, it gradually took over symbolic load of power and chivalry, while during the epoch of Renaissance it became a symbol of wealth.

The Ancient Kingdoms of Colchis and Iberia

In Early Bronze age, on the territory of the Caucasus two Kartvelian kingdoms: the Colchis and the Iberia were formed.

The Colchis

The Colchis has been a powerful ancient kingdom on the eastern coast of the **Black Sea**, formed at the beginning of second millennium BC, a central part of which is the modern **West Georgia**. **Colchis** is described by the modern science as “the earliest state formation of Georgians”, that together with the **Kingdom of Iberia**, would later lead to the formation of the Georgian nation (Allen, 1932). Internationally, **Colchis** is perhaps best known for its role in the Greek mythology, most notably as the destination of **Argonauts** voyage, as well as the home of **Medea** and **Golden Fleece**. Its geography is mostly assigned to what is now the western part of **Georgia** and encompasses the present-day Georgian provinces of **Abkhazia**, **Svaneti**, **Samegrelo**, **Imereti**, **Guria**, **Racha**; **Sochi** and **Tuapse** districts of the modern-day **Russia** and **Trabzon** and **Artvin** provinces of the present-day **Turkey** (Fig. 7) (Braund, 1994).

The eastern **Black Sea** region in antiquity was home to the well-developed **Bronze Age** culture known as the **Colchian culture**. In at least some parts of **Colchis**, the process of urbanization seems to have been rather advanced by the end of the second millennium BC, centuries before any **Greek** settlement of the **Black Sea** coastline (Fig.7). The **Colchian Late Bronze Age** (XV-VIII century BC) saw the development of significant skill in the smelting and casting of metals that began long before this skill was mastered in **Europe** (Braund, 1994).

Colchis was inhabited by a number of related but distinct tribes whose settlements lay along the shore of the Black Sea. The **Kartvelian** tribes differed so completely in language and appearance from the surrounding **Indo-European** nations that the ancients provided various “wild” theories to account for the phenomenon (Urushadze, 1984). For example, **Herodotus** states that the **Colchians**, together with the

Egyptians and the **Ethiopians**, were the first to practice circumcision, a custom which he claims **Colchians** inherited from remnants of the army of Pharaoh **Sesostris III** (1878-1841 BC). **Herodotus** thus erroneously regarded the **Colchians** as **Egyptians** (**Herodotus, The History**).

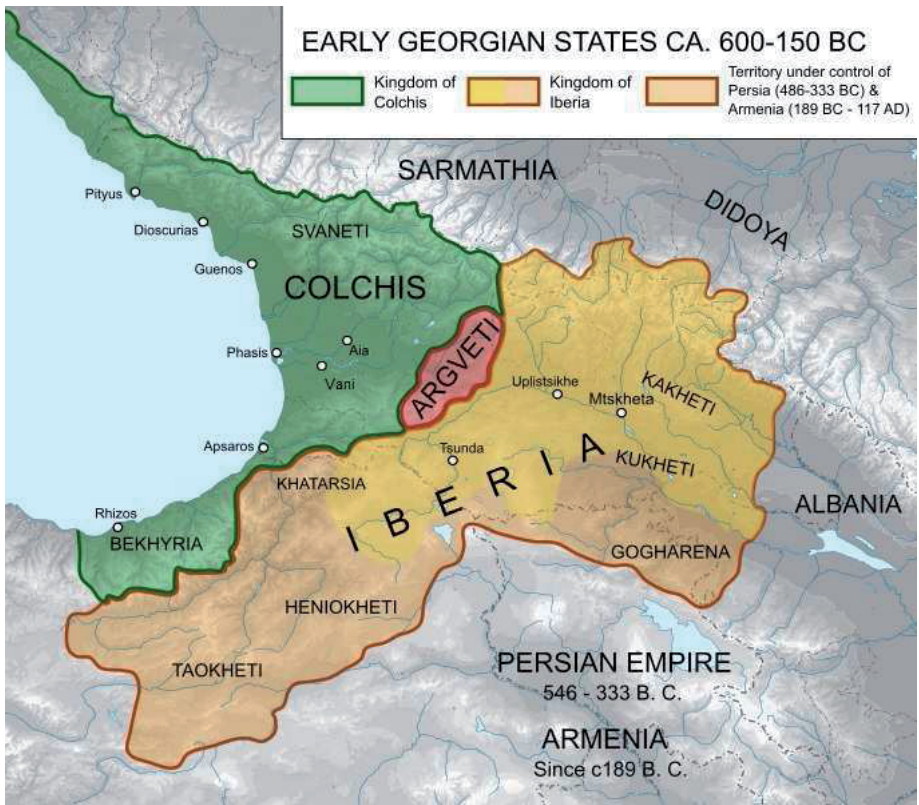


Fig. 7. Political map of the Eastern Black Sea region in VI-II cc. BC Adapted after D. Braund (1994).

According to the Greek sources, the ancient **Colchis** was a powerful kingdom. At the turn of the 15th and 16th centuries BC, the capital city of **Colchis** was **Aya** (the modern-day city of **Kutaisi**), where mighty **Aeëtes** reigned. **Colchis** has sort of "disappeared" further down the history, reappearing later, in the 8th century BC, when the kingdom regains strength after victorious wars with **Sarduri II**, king of

Urartu in 750-742cc BC. The following centuries saw the decline of ancient **Colchis** due to incessant invasions of **Scythians** and **Cimmerians** and by the middle of 6th century BC, **Colchis** falls under the dominance of the **Persian Empire** what effectively marks the end of its early history.

From the end of 6th century BC, the **Black Sea** coast comes into spotlight of Greeks. Greeks have set up commercial ports of Rizos, Gonio-Apsaros, Phasis , Dioscuria (Sebastopolis) and Pitiunt along the Colchian coast of the Black sea. The ports developed into prospering Greek cities later. This was a birth of a new period in the history of **Colchis**, the period of Greek colonization. After a severe defeat sustained by **Darius the III** to **Alexander the Great** in the battle of Gaugamela in 331 BC, the **Persian Empire** lost the last of its influence over the **Kingdoms of Colchis and Iberia**, having given them a chance to develop independently.

The first century BC brings expansion of the **Roman empire** to the **Caucasus** and to the entire Eastern **Mediterranean**. It is when the ancient kingdoms of **Colchis** and **Iberia** are conquered by Roman troops led by the famed General **Pompey**, later falling apart into several smaller kingdoms.

The best known among the cities of the ancient **Colchis** was **Aya (c. Kutaisi** in modern **Georgia**), located in the **river Phasis (r. Rioni** in modern **Georgia**) Gorge, where the Greater Caucasus meets the **Colchis valley**, expanding further down to the **Black Sea** coast. According to the Greek mythology and history, **Kutaisi** is a Minoan Epochcity (17th-15th centuries BC) and is reckoned among the oldest cities in the world, therefore. Since the antique times and later too, in the feudal age, **Kutaisi** have been retaining the status of the main city of the **West Georgia** (has been a Capital of **Lazeti, Egrisi** and **Aphkazia**); has been a Capital of the **Single Georgia** for 125 years from 978 AD. As of the present, Kutaisi is still the largest city of the West Georgia with a population of 250 000. Kutaisi is now home to the Parliament of Georgia and other important institutions.

The first written accounts about **Kutaisi** are found in the Greek sources of **the Hellenistic period**, the most important being *the Argonautica* by **Apollonius of Rhodes** (3rd century BC), where **Kutaisi** is referred to as **Kutaya**, the Capital of **Colchis**. The poem says that it was where the mighty, **Aeetes** reigned and the **Golden Fleece** was guarded by a dragon that never slept. According to the excavations, one of the important towns of **Colchis** of the **Greek colonization period** was **Vani**, 40 kms away from **Kutaisi**, a small town at present, with the population of 5000. Archaeological excavations began there in the late 50-ies of the past century, under the guidance of Georgian archaeologists Nodar Khoshtaria and Otar Lortkipanidze.

The excavations have revealed a continuous occupation sequence extending from the 8th to the 1st centuries BC. Especially notable are the rich and unusual graves of the Classical period (6th-4th centuries) and the monumental stone architecture of **the Hellenistic period** (3rd to 1st centuries BC). It is assumed that in the 3rd to 1st centuries BC **Vani** was a templar city. According to the archaeological data, the city was destroyed in the middle of the 1st century BC (Lortkipanidze, 2001).

There is an interesting archeological museum in **Vani**, with unique artifacts of the **Greek colonization period** exhibited. The collection encompasses a period between VIII and I centuries BC. One of the exhibitions includes a **city of temples** that is most representative of the **Vani culture**. Architecture, gold jewelry, bronze figurines and fragments thereof are put on the permanent exhibition.

Because of the large number of unique gold artifacts unearthed in **Vani** (Fig. 8 and Fig. 9), many scholars and journalists are apt to think that **Vani** is somehow linked to Argonauts journey and some regard it as a Golden Fleece city. However, factual data suggests that the Argonauts represented the **Minoan civilization** and should have therefore travelled to **Colchis** much earlier (by about 1000 years), than **Vani** has reached the apex of its development during **the Hellenistic period**.



Fig. 8. Golden bracelets (H - 6.5 cm; W-6.5 cm) 4th century BC from Vani, (Western Georgia) (The Georgian National Museum's collection).



Fig. 9. Clip Headdress decoration (H - 6.5 cm; H – 6.5 cm), 4th century BC from Vani, (Western Georgia) (The Georgian National Museum's collection).

The Iberia

To the east of the ancient **Kingdom of Colchis**, on the territory of **East Caucasus**, in the third millennium BC, another unity of **Kartvelian** tribes, **Kartli** has formed, referred to in the Greek and Roman sources as **Caucasian Iberia** (Fig. 10). Some scholars (Lortkipanidze 1968) think that, Romans used the term **Iberia** to denote marginal provinces of the empire, what gives a logical explanation to the use of one name for two different places – **Caucasian/Eastern** and **Pyrenees/ Western Iberias**.

The fact that, the territory of the **Eastern Iberia** has been inhabited since the times remote, is clear from numerous archeological findings. In the central part, what is now the **East Georgia**, more specifically in a small town of **Dmanisi**, a very old campsite of humans has been discovered. The hominid site of **Dmanisi** is the earliest of its kind outside of Africa, dated 1.81 Ma (Gabunia et al., 2000). A series of skulls from **Dmanisi** (Fig. 11), discovered in the early 2010-ies, led to the hypothesis that many separate species in the Homo genus were in fact a single age line.



Fig. 10. Map of Iberia and Colchis By German scholar Christoph Cellarius (1638-1707).



Fig. 11. Dmanisi skull 5 (The Georgian National Museum's collection).

The **Grakliani Hill**, an archaeological excavation site in **Eastern Georgia**, located between **Tbilisi** and **Gori**, shows evidence of human presence dating back possibly 300,000 years. The site includes a temple of a fertility goddess from the seventh century BC, a pit-type burial site from the **Early Bronze Age**, and remains of a building from around 450-350 BC. The site had been occupied between the **Chalcolithic** and **Late Hellenistic periods**. In 2015, a mysterious script (Fig. 12) was discovered on the fertility goddess temple altar, predating those previously known in the area by at least one thousand years (Burton, 2015).



Fig. 12. Mysterious script of the Grakliani Hill.



Fig. 13. Uplistsikhe - an ancient cave town in Eastern Georgia. A Christian church, built later, in 6th century AD can be seen in the right upper corner.

In the opinion of Vakhtang Licheli, a Georgian archaeologist: „Mysterious script found on the **Grakliani Hill** may turn out to be the oldest example of native writing found in the **Caucasus** – entire thousand years older than any indigenous writing previously found in the region“.

Among the oldest settlements of **Iberia**, the best preserved so far is **Uplistsikhe**, a town hewn in the rock, 10 km to the East of **c. Gori**, on the left bank of the **River Mtkvari** (Fig. 13). The city was cut out in the limestone rock in the **Early Bronze Age**. **Uplistsikhe** was an important strategic and commercial city of the region, prospering until the 6th century AD, when **Iberia** was conquered by **Sassanid Persia**.

In the 4th century BC, the Capital of **Iberia** became **Mtskheta**, where numerous archaeological monuments are still preserved, the ruins of the 4th century **Armazi citadel** among these. The kingdom has been around as an independent state until 6th century AD, when it became a part of the **Sassanid Persian Empire** as a vassal country. Later, in the 10th century AD, the **kingdoms of Iberia and Colchis** have united, forming a **Single Kingdom of Georgia**, with **Tbilisi** becoming the capital. The Single Georgian kingdom has reached the apex of its development in 11th and 12th centuries, representing by that time the most powerful state in the region. However, the invasion and occupation by Mongols at the beginning of 13th century has stalled its development, weakened and later dismembered the kingdom into small principalities.

By the end of the third and beginning of the second millennium BC, on the territory of **Iberia** a so called **Trialeti culture** began to develop, which is seen as a successor of the **Kura–Araxes culture** (Kouftin, 1941). The **Trialeti culture** has produced numerous gold artifacts of the highest artistic value. The Golden lion of Tsnori (Fig. 14) and Golden chalice of Trialeti (Fig.15) are among the examples thereof. In general, the abundance and the quality of gold artifacts are strong evidence that at those times, in **Iberia** and the region as a whole, gold mining and processing technology has been developed to the highest standard.



Fig. 14. Golden Lion figurine (L- 4.1 cm; H – 2.1 cm; W – 2.5 cm). 2300-2000 BC.
Tsnori, Alazani Valley, East Georgia/Iberia (The Georgian National Museum's collection).

In general, the ancient kingdoms of **Colchis** and **Iberia** have always been reckoned among the world's most important places of mining and processing of precious metals. Many archeologists and other scholars consider the territory inhabited by the **Mossinik**, **Halyb** and **Tubal protoGeorgian** tribes, a birthplace of metallurgy (Richardson, 1934; Forbes, 1950; Wainwright, 1936). In particular, H. Richardson (1934) believes that iron mining and steel manufacturing technology was developed in XIV century BC by a **proto-Georgian** tribe of **Khaldes** that inhabited the **River Halyse** Canyon (vicinity of modern Trabzon, Turkey). Interestingly, R. Dussaud, a French scholar (1930) links the Greek term “chalkos”, a designation for copper, with the **Colchian** tribe of **Khaldes**. He thinks that the root of the word “khal” comes from the word “khaldi”, whereas the suffix “kos” denotes the origin in Greek. Besides, excavations of the **Early Bronze Age** burial

mounds have shown that nonferrous as well as ferrous metallurgy was developed to a highest standard in the region and that the noble metal mining has also taken place there, at that time of history (Courcier at al., 2008).



Fig. 15. Coblet. Gold, carnelian, lapis lazuri, amber, jet. (H-7.5 cm; max. dm-7.5; weight – 230 gr.) Trialeti, Southeast Georgia/Iberia. 18th-17th century BC. (The Georgian National Museum's collection).

Gold artifacts that could have been attributed to the culture of ancient **Colchis** either have not survived or have to be found yet. The earliest gold wares known to us are those from the century V BC, found mainly in the excavations of **Vani** (see Fig. 8 and 9). However, the highest standard of art, these artifacts exhibit, suggests that processing of this precious metal in **Colchis** began long before the V century BC. The fact that no historic structure or a significant artifact of the ancient kingdom of Colchis have been discovered so far, can be blamed on the humid climate of the Colchis valley, intensive precipitation and submersion. However, all these yet can be found in the future.

Thus, the analysis of this chapter leaves no doubt that on the territory of the modern-day **Georgia** man has lived since the prehistoric times. **Iberia** and **Colchis** were ancient kingdoms that have been around since the **Old Bronze Age** until 10th century AD, when they merged to form the **Single Kingdom of Georgia**. Both ancient kingdoms have been known for a well-developed gold processing technology, which gives reason to believe that the gold mining technology was developed just as well. Further, the analysis allows concluding that the ancient **kingdom of Colchis** really existed during the **Old Bronze Age** - the time of Argonauts and was nothing like a mythical kingdom.

Historic and Ethnographic description of Svaneti Region

Svaneti (Suania in ancient sources) is a historic province of the ancient Georgian **Kingdom of Colchis**, near the **Black Sea** (Fig. 16) and is a home to Svans, a geographic subgroup of the Georgians. In ancient sources Svans are generally identified with the Soanes mentioned by the Greek geographer **Strabo**. **Svaneti** lies on the southern slopes of the central part of the **Greater Caucasus** and is the highest permanently inhabited area of **the Caucasus**. The province encompasses the basins of the rivers **Enguri, Kodori** and **Tskhenistskali** (6770 km²), with all three rivers running into the **Black Sea**.

The inhabited areas of **Svaneti** are located along the river gorges, at 1000-2300 meters above sea level, with the village **Ushguli** (2300 m a.s.l.) (Fig. 17) being one of the highest continuously inhabited settlements in **Europe**. The villages are overlooked by magnificent 3500-5200 meters high summits of the **Greater Caucasus**, covered with perpetual snow and glaciers. Out of 10 tallest summits of the **Caucasus**, 4 are on the territory of **Svaneti**. These are: **Shkhara** (5201 m asl – Fig. 18), **Tetnuldi** (4960m a.s.l.), **Ushba** (4710 m a.s.l. – Fig.19) and **Aylama** (4525 m a.s.l.). **Mount Ushba**, the iconic peak of **Svaneti**, towers over the **Inguri River Gorge** and can be seen from many locations of the region.

Because no enemy including the Mongols has ever conquered **Svaneti**, Svans have retained their cultural and ethnic identity. Svans speak their distinct language and use it alongside Georgian. About 25000 people lives in **Svaneti** permanently. **Mestia** is the regional administrative centre (Fig. 20). The river **Enguri** gorge, called the **Upper Svaneti** due to its geographic location, is the historical center of the province, where the cultural heritage of **Svaneti** is best preserved. The **Upper Svaneti (Mestia** district) is known for its architectural monuments and picturesque landscapes. The famous towers of **Svaneti**, built in 9th-12th centuries, for the most part (see Fig. 17 & Fig. 18), add to the attractiveness of the region's villages. Architectural monuments of **Upper Svaneti** have been included in the **UNESCO's World Heritage list**.

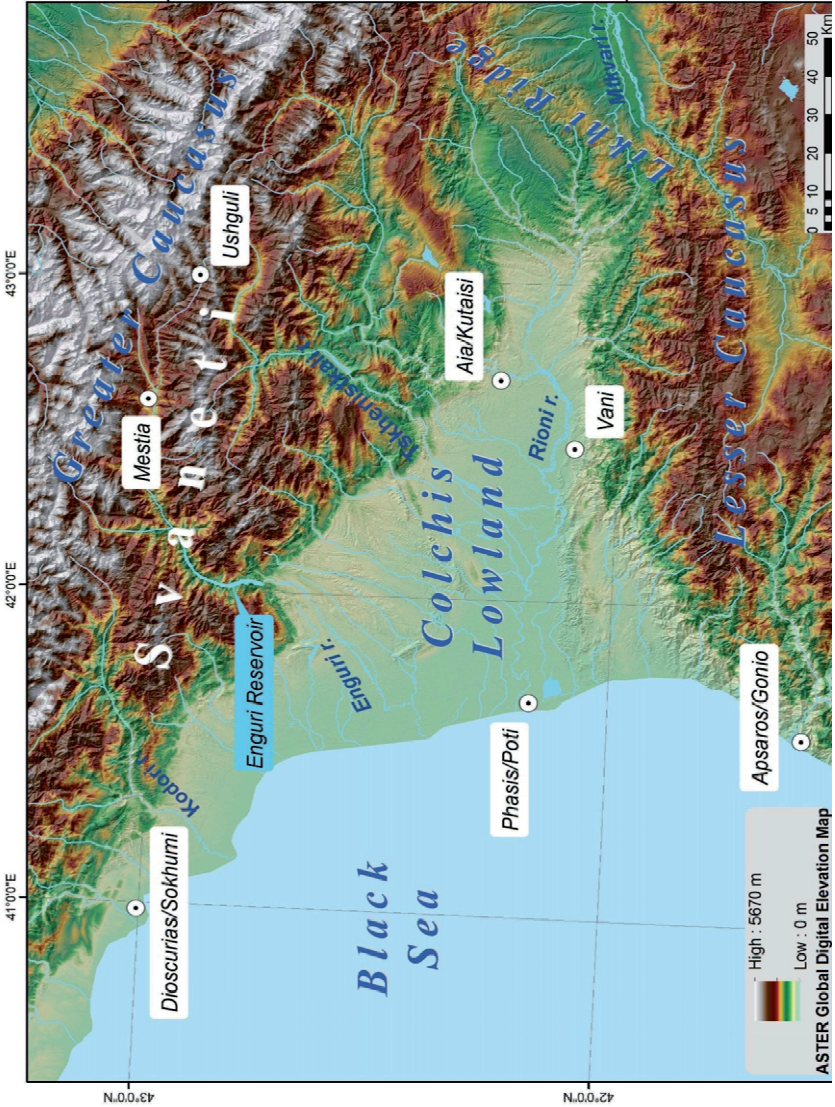


Fig. 16. ASTER Satellite images of modern-day Colchis Lowland and Svaneti Region.



Fig.17. Part of Village Ushguli and upper reaches of the Enguri river.



Fig. 18. The upper reaches of the river Enguri and the granitoid massif Shkhara. The highest point is Eastern/main Shkhara, 5201 meters tall. The massif is a 320 Ma. (the age is determined with use of LA-ICP-MS- U-Pb single zircons dating method).



Fig. 19. Ushba, the beauty of Svaneti, 4710 metres tall. It is a 177 million years old quartz diorite intrusive of the Middle Jurassic (the age is determined with use of LA-ICP-MS- U-Pb zircons dating method).



Fig. 20. Town of Mestia – the administrative center of Upper Svaneti with Greater Caucasus Main Ridge on the background.

The written accounts about **Svaneti** and the Svan people exist since the antique times and mostly narrate about the bravery of Svans and the abundance of gold in the land. **Strabo**, a renowned Greek historian (44 BC- 23 AD) has been writing in his 12th book, that Svans, the people famous for their bravery, lived high up in the mountains of **Caucasus**, just over **Dioscuria** (the modern **Sukhumi**), had a chief, a council of 300 men and were capable of mobilizing a 200 000 strong army. Of a special interest are his accounts of the gold mining in the rivers of **Svaneti**. Here's what he writes: "In mountain rivers of this country there is a lot of gold, mined by these barbarians using the perforated vessels and sheepskin" (**Strabo**, book-XII).

Pliny the Elder, a Roman naturalist (23-79 AD) referring to Svans as to heroic people has been writing in his book "The Natural History": „, in **Colchis** who on finding a tract of virgin earth, in the country of the Suani, extracted from it a large amount of gold and silver" (Pliny, vol. 6). This information draws a special attention since **Svaneti** is mentioned there as a part of the **kingdom of Colchis** - an important point when discussing the mission of Argonauts.

In assessing the mission and the **Golden Fleece** in general, very interesting are the accounts and reasoning of **Appian of Alexandria**, a Roman historian (95-165 AD) who writes in his book "The history of Mithridates wars": "many rivers carry invisible "gold sand" from the **Caucasian** mountains and residents put thick sheepskins into the springs and then collect precipitated gold". In his opinion, the main objective of the Argonauts mission was to obtain the sheepskin technique of gold mining and that the "**Golden Fleece**" of **Aeëtes** represented a sheepskin with imprinted gold.

We should note here that, geologically, this method is justified, with the secret possibly being that, gold as a heavy metal sinks to the bottom of the sediment. Due to this quality, a sheepskin accumulating the sediment is gradually covered with gold specs that stick to the wool. The ancient **Colchians** should have known about this character of gold and used it quite successfully.

A close acquaintance with the lifestyle of the Svan shows that there is a “close and distinct” relation between this people and the nature, the “sheepskin gold mining” technology being an example thereof. Before moving on to the technology, we refer to the brief description of **Svaneti** and **Svans** by the **UNESCO World Heritage Centre**: “Preserved by its long-lasting geographical isolation, the mountain landscape of the **Upper Svaneti** region is an exceptional example of mountain scenery with medieval villages and the abundance of tower houses. The origins of **Svaneti** tower houses go back to prehistory. Its features reflect the traditional economic mode and social organization of Svan communities. These towers usually have three to five floors, and the thickness of the walls decreases, giving the towers a slender, tapering profile. The upper floor was used by the human occupants during summer, and also served as a store for fodder and tools. The region of **Upper Svaneti** is an outstanding example of an exceptional mountain landscape composed of highly preserved villages with unique defensive tower houses, examples of ecclesiastical architecture and arts of medieval origin“.

Of interest are scientific theories about the origin of the Svan. A part of the scholars (M.Tsereteli, A.Svanidze) think that they might have been a relict tribe of the **Sumerians** that found refuge in the inaccessible Caucasus after the downfall of their kingdom 5000-4500 years ago. Here, strictly confined, they have preserved their identity way better than the people of the lowlands. As an argument, they bring the similarity of place names and language, together with some other factors - the shape and style of the Svan towers among these. Supporters of the idea insist that the towers clearly reflect the influence of **Sumerian ziggurats**. However, the gold mining technique used by Svans is closer to that of the **Egyptians**, as thought by **Herodotus**.

In general, Svans are romantic warriors that are in love with art, which is well expressed in their wonderful folklore and the diverse medieval wall-painting. **Svaneti** is the only part of **Georgia** where churches have been painted both from inside and outside. A church of village **Lashtkhveri (Lenjeri** commune) with all four

outer walls covered with paintings, can serve as an example. The frescoes of this church depict warriors among other, which is unique for Georgian wall-painting (Fig. 21).

Legends and myths occupy an important place in the existence of the Svan - yet another expression of their romantic nature. In many cases, these legends and myths reflect the reality, as this people have been living here for more than 4000 years, without any assimilation from outside and their historic memory is unbroken and solid, therefore. Mythology of Svans merits attention and interest for its antiquity and content that is close to the truth and shows a rather clear proximity to the ancient Greek world: Prometheus – Amirani, Gea – Gim, etc.



Fig. 21. Fragments of frescoes of the Holy Warriors, south wall of Lashtkhveri church facade, 14th century.

The theme of the **Argonauts** and the **Golden Fleece** is widely reflected in the Svan mythology. The local elders still firmly believe that **Argonauts** have indeed travelled to their country. Besides, during the excavations around the villages of **Svaneti**, archeologists have found numerous bronze figurines, that represent a stylized bird with a ram's head (Fig. 22 and Fig. 23). It is very much likely that such statuettes were being created under the influence of the **Golden Fleece** legend and should not be linked to a totemic faith.

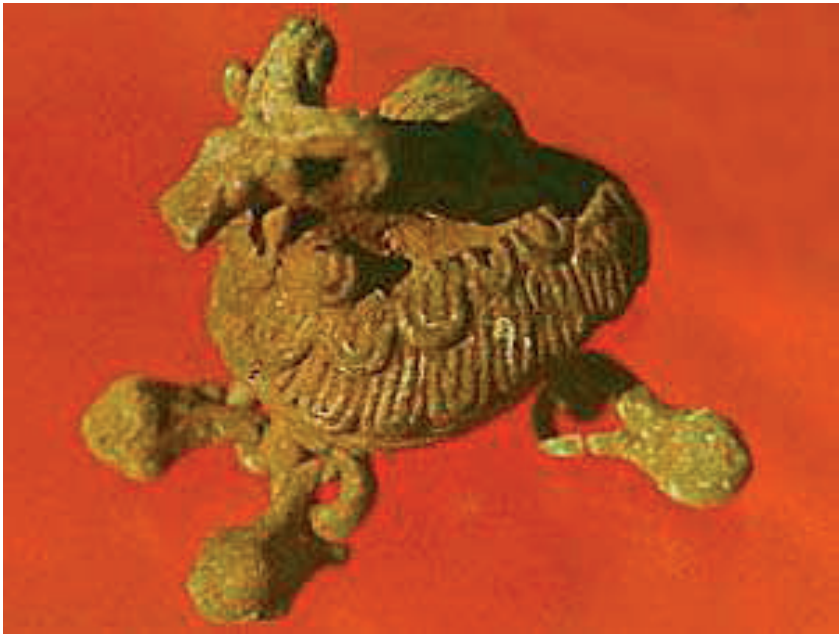


Fig. 22. A bronze ram figurine. Upper Svaneti.
(From Sh.Chartolani Collection).

Thus, obviously, the Svans are a people with an ancient history, mentioned in the written sources of antiquity, who have firmly kept their traditions, lifestyle and language. Besides, they have a highly organized labor and optimal forms of interrelation with the nature. Most likely, the strong traditions, the organized labor, the morale, together with inaccessibility of the area have provided for the

autochthony of Svans from the **Bronze Age** till present. That is why; the mythology of Svans is ancient, pristine and often bears the imprint of true events of the antique history.



Fig. 23. A „Ram Bird” bronze figurine (7X10 cm). Villige Khalde, Upper Svaneti (From Sh.Chartolani Collection).

In the next chapters we’ll discuss, how close to the reality is the most famous legend of antiquity from a geological point of view. Besides, we’ll check the written accounts of antique scholars, - **Strabo**, the great geographer among these, - about the gold that was being recovered from the Mountain Rivers of **Svaneti** and see if this information is a mere echo of the Argonauts legend.

A general geology of the Caucasus

The Caucasus represents a Phanerozoic collisional orogen formed along the Euro-Asian north continental margin, in a NW-SE direction, from the Black to Caspian seas. Currently, it is an expression of continental collision between the Arabian and Eurasian lithospheric plates (Fig. 24).

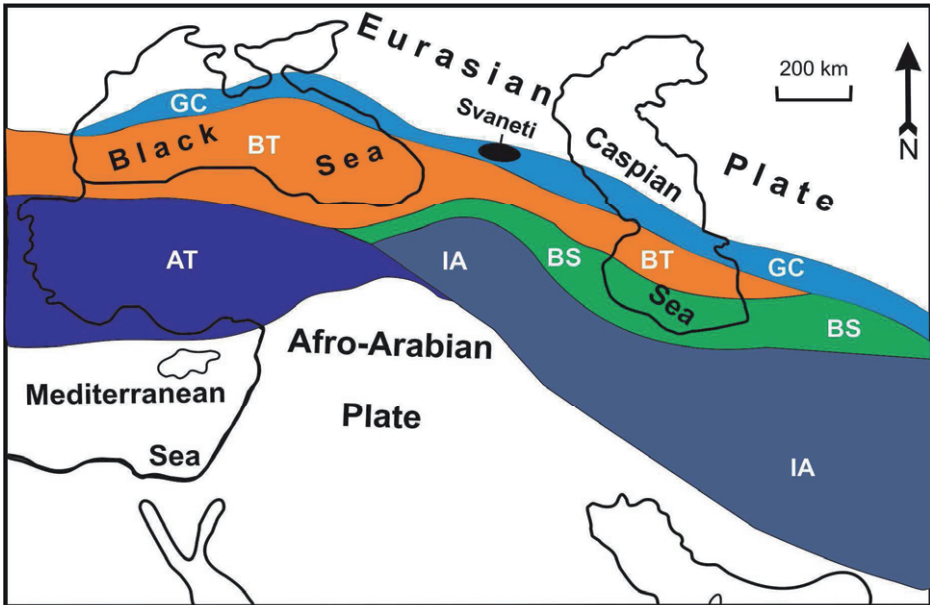


Fig. 24. Tectonic zoning of the Eastern Mediterranean on the basis of terrane analysis (after Gamkrelidze, 1997). Terranes: GC- Greater Caucasian, BT- Black Sea-Central Transcaucasian , BS-Beiburt-Sevanian, IA-Iran-Afganian, AT –Anatolian.

Paleomagnetic and geological data indicate that within the oceanic area of Tethys, which separated Afro-Arabian and Eurasian continental plates, there were relatively small continental or subcontinental plates (terrains) with different geodynamic and geological histories (Gamkrelidze 1997; Okrostsvaridze, Tormay, 2013). During the Neoproterozoic, Paleozoic and Early Mesozoic, these terrains underwent horizontal displacement within the oceanic area of Proto-, Paleo- and Meso-Tethys, followed by accretion and, ultimately, merging with the Eurasian continent. The Arabian and

Eurasian lithospheric plates are separated by the Greater Caucasian, Black Sea-Central Transcaucasian, Baibut-Sevanian and Iranian-Afghan terrains which in the geological past represented island arcs or micro-continents (Gamkrelidze 1997).

Traditionally three major orogenic units are distinguished in the Caucasian construction: 1) the Greater and 2) the Lesser Caucasian mobile belts and 3) the inner Caucasian microplate. The Greater Caucasus unit is the northernmost expression of the Caucasus orogeny and is linked to the southern margin of the Eurasian continent. It is currently a folded-nappe polycyclic formation extending more than 1200 km between the Black and Caspian Seas; its width reaches 170 km in the central part. Two major stages are distinguished in its construction: Pre-Mesozoic crystalline basement (CB) and Meso-Cenozoic volcanic-sedimentary cover. Crystalline basement complex (200kmx40km) is mainly constructed of Precambrian and Paleozoic crystalline chist, amphibolites, gneisses, migmatite and granitoids. Four regional structural- tectonic zones are traditionally recognized: Southern Slope, Main Range, Front Range and Bechasyn.

Evolution of plutonic magmatism is clearly observed in the Variscan tectonic-thermal events of the Greater Caucasus. Mantle origin gabbro-plagiogranite series is formed (355 ± 15 Ma) at initial state of the process at the southern margin orogen in subduction zone. During 320 ± 8 Ma mantle-crust generated gabbro-adamellite series formed just above the subduction zone. Much later (310 ± 7 Ma) crustal anatectic plagiogranite-granite series started formation of collision structure. The Greater Caucasian Variscan plutonic magmatism is ended by granodiorite-alaskite series (300 ± 5 Ma), which formed at the expense of the upper Caledonian granite (Okrostsvaridze, Tormay, 2011).

Geological description of Svaneti Region

Svaneti region is located in the southern part of the most uplifted central segment of the Caucasus orogen. It includes the outcropping Paleozoic crystalline basement of the Main Ridge and of the Southern Slope zone, overlain by Early and Middle Jurassic volcanogenic-sedimentary formations and Middle-Upper Cretaceous limestone. The Main Ridge zone in the **Svaneti region** is represented by older Early-Middle- Paleozoic amphibolites, crystalline schists, migmatites intruded by Upper Paleozoic quartz diorites, granodiorites and granites. The Southern Slope zone in the **Svaneti** area is represented by the Upper Paleozoic-Triassic volcanogenic-sedimentary and sedimentary rocks so-called Dizi series, which forms two lens-shaped “windows” within the Jurassic sedimentary cover.

Magmatism of the Svaneti region

In this chapter, we are going to describe magmatism of the Caucasus Svaneti segment in a relatively more detail, because it is genetically linked to the bedrock gold mineralization processes. We have determined magmatic activity stages with the use of single zircon U-Pb dating method on the LA-ICP-MS equipment of **the department of Earth and Environmental Science of the National Chung-Cheng University, Taiwan**, having distinguished several stages of magmatic activity as a result. We should note here that, the magmatic processes of **Svaneti region** have been dated by many researchers before (Gamkrelidze, Shengelia, 2005; Okrostsvaridze, 2007; Okrostsvaridze, Tormay, 2011; Dudaury, Togonidze, 2016), albeit, the recent work has led to significant new findings.

According to the geological data, as well as to the zircons dating, the oldest igneous activity in the **Svaneti segment** was anatexic magmatism of the **Elbrus** subzone of the main range, which was linked to the Early Caledonian orogeny - 500-450 million years (Ma). From these bedrocks, we have dated the zircons of biotite migmatite, which corresponds to an average age of 475 Ma.

Further magmatic activity in the **Caucasus Svaneti segment** is linked to the Late Caledonian orogeny (450-400 Ma). During this period, plagiogneisses have formed here, dated with zircons at an average of 554 Ma.

Further magmatic activity in the **Svaneti segment** is related to the Variscan orogeny (280-380 Ma), which on its part was linked to the closing processes of the Paleo-Tethys. The period in the region was marked by intensive magmatic activity with different genetic types of plutonic bodies formed in the sub-zones of the both, the mountain pass and the Mount Elbrus. During this latter, a crustal, two mica granitoid magma formed (305-320 Ma), genetically not related to any ore mineralization process. In contrast to this magmatism, ore mineralizations are associated with the quartz-diorite plutones of the mantle-crust generation that have formed in the mountain pass sub-zone. The largest is **Sakeni** intrusive (15km X 5km) with large ore fields formed in the south and north contacts. We have dated zircons from this intrusive, with the average determined at 318 Ma (Fig. 25).

The next large magmatic activity in the region occurred in the Middle Jurassic period and is linked with the Kimmerian orogeny caused by the closure of Mesothetis (150-200 Ma). During this period, in crystalline basement are formed Quartz-Diorite and Granodiorite intrusive bodies of various scale. We have dated zircons from these bodies with and their isotopic ages scattered across the 177 -164 Ma interval. **Ushba-Etseri Intrusive complex** was dated as the oldest (177 Ma) (see Fig. 18). With this magmatic activity is often genetically connected ore mineralization process, of the gold - including.

Apart from the largescale magmatic activity described above, the Alpine magmatic processes have intensively manifested during the Neotethis closure in the Caucasus (< 65 Ma). In the course of this period, the Meso Cenozoic cover of Svaneti was intensively innervated with multitude of quartz veins of various strengths, the gold-bearing - among these.

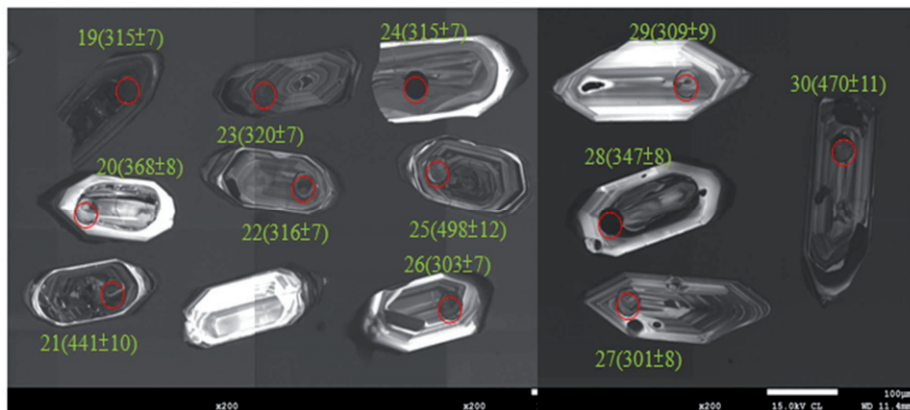


Fig. 25. Images of Sakeni quartz-diorite intrusive zircons (in the brackets-age in Ma).

Thus, as we can see from this brief review, intensive magmatic processes have been going on during the full length of evolution of the **Svaneti segment** of the **Caucasus**. We have distinguished 5 phases of the active magmatism, in particular:

- 1) The Early Caledonian, in the course of which intensive migmatization of the substrate occurred;
- 2) The Late Caledonian, during which the plagiogneisses formed;
- 3) The Variscan, when the two mica microcline granites and quartz-diorite powerful intrusions formed;
- 4) The Cimmerian orogeny, during which the diabase Dike systems and quartz-diorite and granodiorite intrusions formed;
- 5) The Alpine Magmatic Activity, during which formed the multiple quartz veins dissecting the Meso-Cenozoic sedimentary cover.

Long-term geological study of the region has shown that, from the magmatic activities, only the phases 3, 4 and in part 5 are connected with the gold mineralization. These very activities have provided for the formation of main gold deposits of **Svaneti**, whereas, formation of the placer deposits – the Gold Sands, happened through transportation of the broken material by rivers.

A General Description of Gold Deposits

There are very few deposits of gold on the Earth, since the gold average content in the Earth's crust is very small, more specifically - about 0.0031 g/t. Figuratively, formation of the gold deposits in the Earth's crust happens in very rare, lucky occasions. Formation of the most part of the gold deposits takes place in the depth of the Earth's crust. These are primary, endogenous deposits. The smaller part of the deposits is being formed on the surface, as a result of disintegration of the basic, hard rock deposits.

These are secondary, exogenous deposits. There is a significant difference in gold concentrations between the placers and the basic deposits. More specifically, in the hard rock deposits gold is a compound within various minerals. In very rare occasions it may crystallize in a bedrock crack, whereas in the placers, the gold grains and rarely nuggets are contained mainly in a loose material. Accordingly, in the placers gold can be extracted by way of mechanical separation, whilst from the primary deposits it is extracted with chemical process.

In the course of the long geological time due to tectonic movements, rock deposits come to the surface, break up and are washed away. Secondary, exogenous gold deposits are formed in this process, most of which is placers. Their formation is conditioned by the above disintegration and subsequent displacement of the primary Au-containing ores. The process is long and complex, during which gold grains are released from the minerals and taken away with streams. However, due to the high density of gold (about 19 g/cm³) the grains more than 0.5 mm in size are not carried a long distance and are deposited in a few hundred meters or kilometers from the main ore while the smaller specks are transported farther. That is why the alluvial deposits are the most profitable, since the gold particles can be extracted here by way of mere flushing out. Historically, it was precisely the alluvial/placer gold that attracted attention and it is only natural that men began extracting gold first from the deposits of this category.

History and methods of gold mining

There are several methods of gold extraction in the mining industry, more specifically: amalgamation, cyanide, biological and manual methods.

Amalgamation. Amalgam is a compound of mercury and metals. Mercury has a property to encase the finest particles of gold and other metals (except iron) at the room temperature and encapsulate them. It does not chemically interact with gold and the metals, however. This is how silver, gold, zinc, lead and other metals are being amalgamated. After the process is completed, the amalgam is extracted and the obtained compound heated; the highly volatile mercury (melting point 38.8°C) evaporates releasing the pure metal. The process was first used in Mexico in 1557 for extracting silver from placers. It became widespread in USA in 19th century (Voinick, 1992) and at present is successfully employed for extracting gold across the Globe.

Sodium cyanide (NaCN) process. It is worth noting that, solubility of gold in sodium cyanide was discovered in 1843 by a Georgian chemist, **Petre Bagraioni**, who worked in Petersburg, Russian Empire, at that time. Extraction of gold with sodium cyanide process was first carried out by the gold industry of the USA, at the end of 19th century. At present, the method is widely spread across the board due to its low price. The process is simple: finely powdered enriched auriferous ore is sprinkled with sodium cyanide, which dissolves gold and deposits it on the bottom. The bottom is covered with a special non-conducting surface where this mass is being accumulated. Then the upper, leached mass is removed and gold is extracted from the enriched mass of the sediment.

Biological process. The method was developed in 1958, in USA. It is based on the ability of some microorganisms (bacteria, fungi) to generate cyanide, providing thereby the means for leaching gold. The process is as follows: first the naturally occurring microorganisms, or those genetically engineered are infused into the metal containing ore; next the shaft is filled with water, with the metals afloat; next the

shaft is drained. The method can be used not just for gold but for some other metals too, such as copper, zinc, etc. A disadvantage is the length of the process - an average of 6 months.

Manual process. It is the oldest technique around and is based on removal of mechanical waste from the gold-bearing gravel of the placers. The method is facilitated by the high density and stable chemical properties of gold. It is to say that, gold is 79 times heavier than water and about 7 times heavier than gold-bearing gravel. At the same time, this element interacts with no naturally occurring matter under the temperatures normal for the Earth's surface. Since gold is present in the placers as a mechanical admixture, it can be manually washed out with water stream. This is the oldest and the simplest way of gold extraction; it has been used since the ancient times and is still being successfully used. There are many diverse options. It should be noted that until the 20th century, gold has been mined mostly in the gold placers across the globe and the notorious **Gold Rush** of the 19th century in the United States was about gold mining from the placers exactly (Voinick, 1992).

The oldest gold artifacts discovered in **Varna necropolis, Bulgaria, are dated between 4700-4200 BC**. Therefore, gold has been known to and has been mined by men 6700-6200 years ago. Unfortunately, there are no data on when and where gold has been mined first, although, it is beyond any doubt that it was first in placers, since it is lot easier than mining from the bedrock deposits.

The first written accounts of gold being mined with manual methods are given in *The History of Nature* (77 AD) by **Pliny the Elder**. In this book he describes in detail the process of extracting gold by the Romans from *Las Medulas* (Spain) placers. The process was as simple as flushing gold out from the sands with a strong stream of water. Due to the significant historic value, the **Las Medulas** deposits have been entered the list of UNESCO world heritage sites.

Mining of gold from rivers with sheepskins has been described as a discrete method by Ruttier, a French scholar of 19th century, who studied technologies of gold mining

from placers and has set apart the sheepskin method as a distinct one, under the name of Colchian method. Worth noting that, locals still wash gold with this method in the river Enguri gorge and the tributaries. A young sheepskin, with dense wool, is a good trap for heavy specks of gold. It is a simple, artisan process. However, discovering and exploiting this technique requires a good knowledge of the Nature. Anyway, for the Early Bronze Age this method should have been rather high-tech.

There are two versions of the technique used in Upper Svaneti, the first one being putting the sheepskin directly in the streambed, securing with sticks to keep it in place, and the second one – flushing sands through a fleece.

Metallogenic Description of Svaneti Region

In spite of relatively small area occupied by **Svaneti** region, numerous examples of significant metallic mineralizations of various genetic types occur there (Fig. 26). In time and space they are linked with the spatially connected magmatic rocks, as well as with the sedimentary formations that are the host rocks to these intrusives. Since 1934, in the time of Soviet Union, near the village of Jvari, mining of gold in the alluvial placers began along the Enguri River and continued until 1957.

Gold sampling resumed in the same area 30 years later (Geleishvili, 1988). The sampling has shown that, within this geologically very insignificant time interval, the gold content in the placers has replenished back to the levels of commercial importance. Naturally enough, attention was immediately drawn to probable “culprits” - gold-bearing bedrock structures of the Svaneti region.

Bedrock Gold Occurrences

During the 1960's-1970's, in Svaneti region, gold prospecting in the sedimentary cover rocks began, with poor results, though. Several ore manifestations have been discovered, but the gold content thereof could not account for the above described replenishment of gold in the placers, over the time interval so short. However, since the 1990's, gold prospecting in the crystalline basement of the Variscan terrain began, resulting in discovery of Sakeni goldfield that is now considered the main source of gold in the placers of Svaneti (Okrostsvaridze, 1992; Kviciani et al., 1997; Okrostsvaridze and Bluashvili, 2009).

Beside Sakeni goldfield, over 60 other ore manifestations have been discovered in **Svaneti**, not yet researched though, due to the complexity and inaccessibility of the relief. Reviewing each of them separately we don't find possible here. However, among these we can set apart the following: Kvishi polymetallic, Khalde gold-

antimony, Tviberi polymetallic, Lasili-Arshiri goldfield, Tetrashera massif sulfidic, Shkenari polymetallic, Szigmazuki massif sulfidic and Lukhra goldfield.

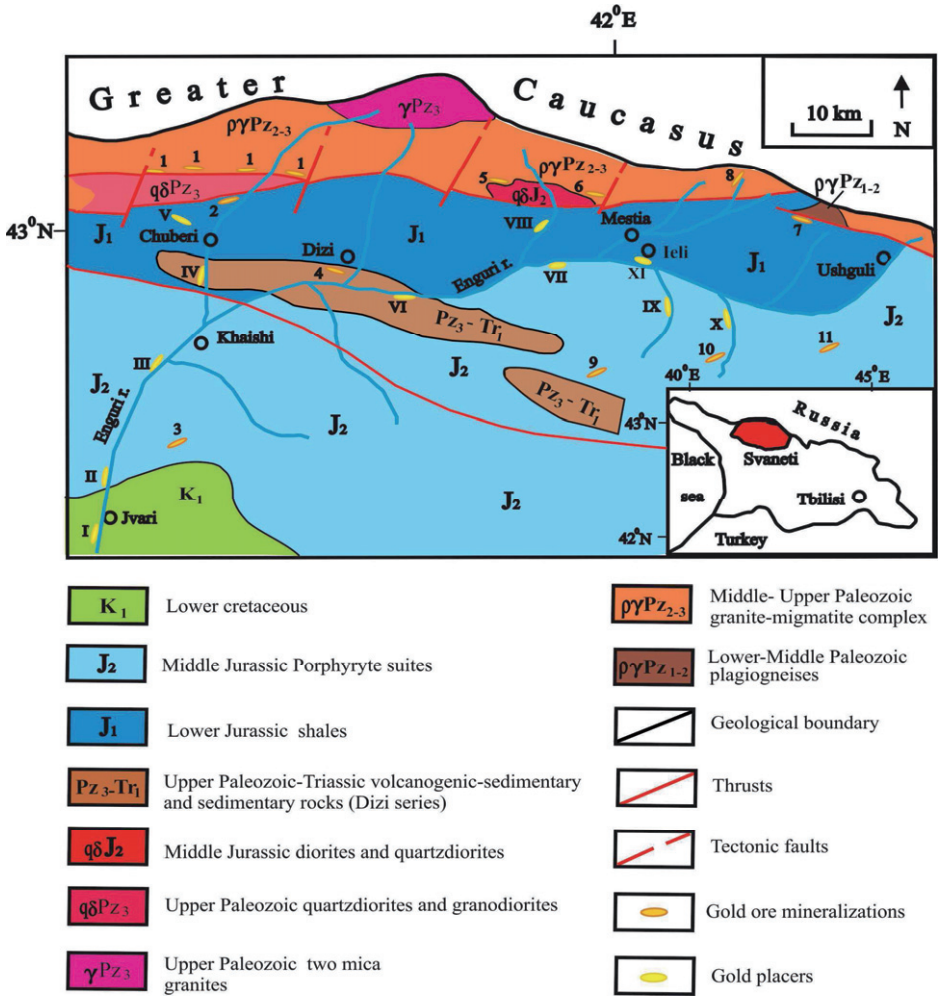


Fig. 26. Schematic geological map of Svaneti region, gold ore mineralization and gold placers. Gold ore mineralization: 1- Sakeni ore fields; 2-Tetrashera; 3-Shkenari; 4-Lukhra; 5-Guli; 6- Kvishi; 7- Szigmazuki; 8-Tviberi; 9-Khalde; 10- Arshira; 11- Lasili; Gold placers: I- Jvari; II- Khudoni; III-Khaishi; IV- Chuberi; V-Kharami; VI- Lakhamura; VII- Latali; VIII- Becho; IX-Arshira; X-Lasili; XI-Iveli.

Presently, Sakeni goldfield is the largest-scale and the best researched ore manifestation of Svaneti. Four gold-bearing bedrock occurrences are known in the Sakeni goldfield (Fig. 27). These include: Kakrinachkuri (1), Hokrila (2), Memuli (3), and Achapara (4) gold-bearing zones.

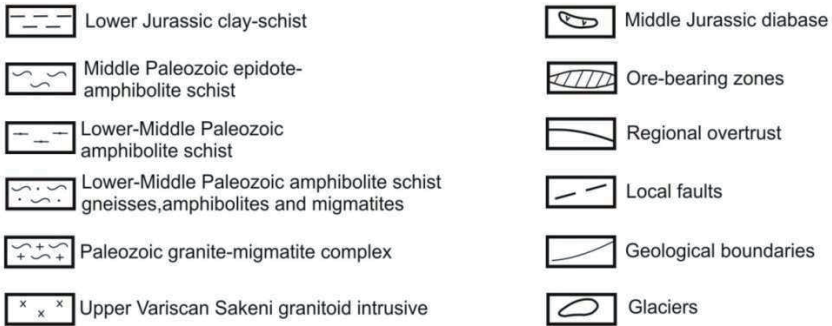
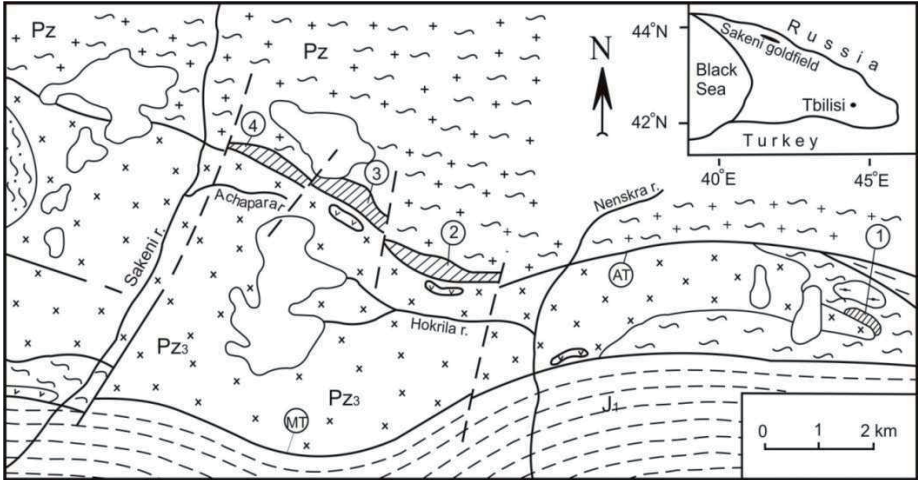


Fig. 27. Geological map of the Sakeni goldfield and recognized gold occurrences.

Au-bearing zones in bedrock: 1-Kakrinachkuri, 2-Hokrila, 3-Memuli, 4-Achapara; Regional thrust: MT–Main thrust, AT-Alibek thrust.

They are localized along the northern border of the Sakeni granodiorite intrusive of Upper Paleozoic generation, whose emplacement is controlled by the Alibeg thrust

zone - the main structure of the region. The mineralized zones are formed in the deformed and greisenized rocks of a Middle Paleozoic granite-migmatite and include quartz veins, pods, and stockworks. Gold occurs with quartz-scheelite, quartz-pyrite-arsenopyrite, and quartz-stibnite assemblages (Fig. 28). The highest gold concentrations (15-80 g/t) are found with the quartz-pyrite-arsenopyrite association.



Fig. 28. Outcrop of Quartz-gold-antimonite ore on the Hokrila occurrence of Sakeni Goldfield.

In the South contact zone of Sakeni intrusive, bedrocks of Dizi series, Tetrashera ore field has formed, represented mainly by a massive pyrite-pyrotine ore field (Fig. 29). The ore field zone is very large; follows the intrusive for a long distance. Copper is the main ore of the field, with the content reaching 1%, with gold content within 0.7-2.2 g/t.

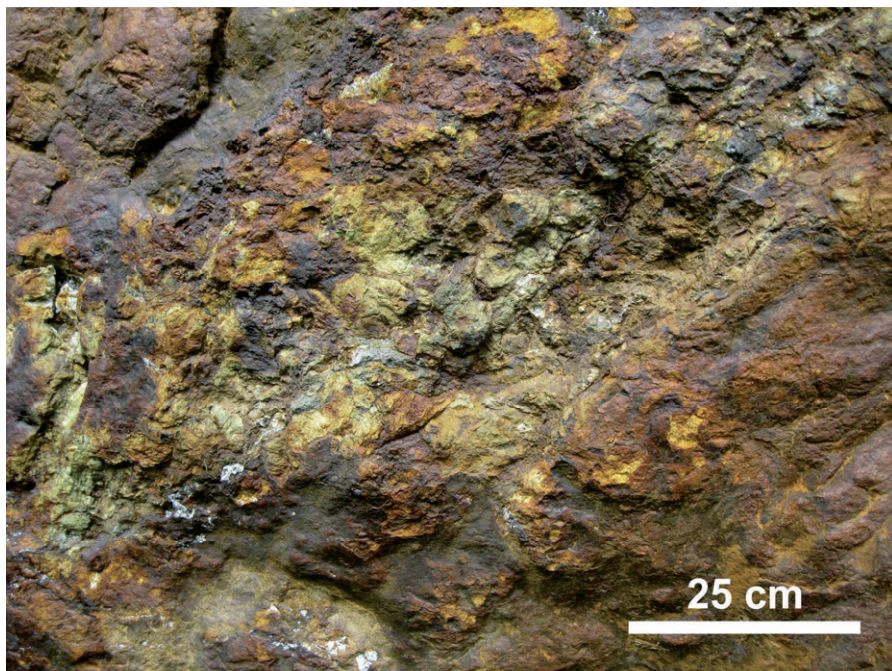


Fig. 29. Fragment of pyrite-pyrrhotite massive ore of the Tetrashera ore field.

From our investigations we can conclude that the genetic model of Sakeni goldfield is: syn-orogenic thermal events have activated a fluid system that mobilized metals from the Sakeni intrusive complex. The fluid was focused along the Alibeg thrust fault, with the mineralization localized along and deposited below structural barriers within the thrust itself. We assume that the gold mineralization represents a post-magmatic, gold-quartz-low total sulfide hydrothermal event; such paragenesis is broadly characteristic of many orogenic gold systems (Goldfarb, 2005).

By an estimate, the ore field should contain 30-32 tons of gold (Okrostsvardize and Bluashvili, 2009). Given the large area of the bedrock gold mineralization and its proximity to the headwaters of the primary river system in the region, we think that the Sakeni goldfield should be one of the main suppliers of alluvial gold to the

Svaneti region. Shown below is a brief description of other gold mineralizations of Svaneti that also represent sources for the placer gold.

The Kvishi polymetallic ore mineralization is exposed on the right banks of the river Dolra, about 15km away from the village Becho (see Fig. 26). The field is associated with a zone of the oxidized, silicified clay shales of the Lower Jurassic period. A 1-1.5 m thick, 80 m long quartz vein is traced in the zone. The average content of the vein for gold is 2.25 g/t; for silver - 125 g/t, for copper – 0.06 %, for lead- 7.5 %, for zinc – 4.8 % (Kviciani et al., 1997).

The gold-antimony mineralization is exposed to the SE of the village Khalde, on the southern slopes of Mt Tsimnari (see Fig. 26). The mineralization is associated with the contact zone between the Lower Jurassic clay shale and several diabase dykes. In the shale, a 6 m wide system of quartz veins has developed parallel to schistosity. Zone is about 40 m long. Analysis of samples from the vein shows the content of stibium within 2.88 % - 37.8 %, of gold - within 0.4 g/t-5.3 g/t, and of silver - 130-362 g/t (Kviciani et al., 1997).

The Tviberi ore mineralization was discovered in 1991 (Okrostsvardidze, 2007) (see Fig. 26). The mineralization occurs within Lower Jurassic clay-shale, some 18 km north from the village Zhabeshi. Gold content reaches here 0.8 -1.7 g/t. The size of outcropping mineralization and its grade (thickness of 180 m and strike extent of over 750 m) have attracted a huge interest.

Lasili-Arshiri goldfield (see Fig. 26) lies in the Enguri River valley, 12 km northwards of the village Eli, in Lower Jurassic clay shales. The mineralization consists of gold-bearing quartz veins, which appear to genetically belong to the mesothermal class of orogenic gold veins. Gold content in these quartz veins varies widely from a few grams to tens of grams per ton (Kviciani et al., 1997). On the territory adjacent to this district, gold sand (placer) accumulations are widespread (see Fig. 25). Nowadays, as well as in the old times, numerous tools used in a primitive gold mining are being found here.

All of the ore occurrences described above have formed at various depths and their exhumation has been triggered by the Alpine orogeny. There is no agreed opinion about exhumation of the Caucasus among the scholars. A part of them, based on the available geological data believes that, exhumation of this structure began in the Middle Miocene, 10-11 million years ago, while according to the recent studies based on apatite thermochronology, a rapid exhumation of the central part of the Caucasus began in Pliocene 5-7 million years ago (Wang et al., 2015).

To all the available data, the ore fields of Svaneti, together with the host rocks, have been eroding and weathering for at least 5-7 million years. The disintegrated material is being transported to the Black Sea by the dense network of affluent rivers and through this complex process, a large area of river placers have formed in Svaneti, with gold- bearing sands among these.

Alluvial Gold Occurrences

As was described above, generally, the placer gold is widespread in almost all alluvial river systems that are draining important bedrock gold districts of the world. Mobilization and transportation of the products of weathering of these deposits are usually the source of the alluvial gold. The coarsest of the gold specks or grains (i.e. > 0.5 mm) use to accumulate near the mineralization sources, while the finer-grain gold is being carried away by streams several kilometers from the source. During the transport and subsequent deposition, the gold grains undergo significant changes in shape, size and chemical composition. As a result of dissolution and re-precipitation after the deposition, the gold grains may increase in size and a “cleansing” of iron, copper, and other impurities take place; this may lead to an increase in the fineness of the gold grains.

The entire territory of Svaneti is dissected with multiple affluent rivers that pertain to the category of highly turbid. Accordingly, the streams flush out and spread in the valleys a huge volume of material, transporting a part of it further down, to the Black Sea. A strong stream can transport a floating material, including a heavy fraction along the full length of the river. As the stream weakens, heavy fractions and the valuable minerals therein, together with other material, begin to accumulate in appropriate geomorphologic structures of the gorge. The minerals are: gold, titan magnetite, scheelite, pyrite, chalcopyrite, zircon, garnet, other.

Because of this, the placer gold of Svaneti is being found mainly in alluvial sediments. Gold-bearing alluvial sands (gold sands) or gold placers are very common in Svaneti and their length varies from few meters to several hundred meters. Due to a number of reasons, both of objective and subjective nature, it is very difficult to determine the precise number and scale of the gold-bearing placers of Svaneti, though the approximate number is known. In the Enguri River gorge the placers are: Latali, Ieli, Tskhumari, Lakhamula, Khuberi, Khaishi, Khudoni and Jvari. Golden sandy ground is also known by the river. Along the right and the left tributaries the placers

are: Adishi, Mestia, Shikhra, Becho, Gulischala, Idliani, Nenskra, Mashrichala, upper and lower Koshrini, Pari, Mushuri, Ushba-Etseri, Tseri and Lahili. Among the gold-bearing alluvial sands of Svaneti we should distinguish Jvari gold placer (see Fig. 25), for the large industrial scale. Lasili and Arshiri gold fields (see Fig. 26) are very significant too; gold mining here dates back to the times prehistoric. Latali gold fields (see Fig. 25) are distinguished by a large scale too. Beside the alluvial gold-bearing sands, gold accumulations in Svaneti are sometimes found in the so called “bear pots”, pits cut out by the stream in the riverbed rock, where a specific, gravity accumulation of gold takes place.

We'll describe below, by way of a model, the goldfield of Arshira, as a result of disintegration of which, gold-bearing placers have formed. The deposit is located on the ridge, at an altitude of 2800-3000 m, in the upper reaches of the river Arshira, left tributary of the river Enguri. In the extended areas of the river gorge, several hundred meters down from the ore, small sandy terraces with a rather high gold content have formed.

The Arshira goldfield is built of multiple (more than hundred) gold-bearing veins that run through a volcanogenic Middle Jurassic porphyrite layer. Thickness of the veins ranges within 0, 2 - 5 meters with the length ranging from tens to hundreds of meters. The veins are homogenous in mineral content and consist of fissured, milky-colored, rarely bluish quartz, with small rock-crystal druses. Some veins include pyrite and siderite, rarely - galenite, sphalerite, hematite, arsenopyrite and antimonite. Iron rust in many places fills the cracks and voids in the quartz. Among the quartz veins distinguish: gold-bearing quartz veins; gold-scheelite-quartz-carbonate veins and polymetallic-arsenopyrite veins.

In the yellowish quartz of the veins, gold is present in the form of scales, or small isometric grains in the voids formed as a result of sulfide leaching. At times it is found as quartz increment or a filler of cracks in the quartz. Grains of native gold of 1,5 grams have been found in the form of increments of a massive quartz. The gold

content of the veins is varying widely, reaching few tens of grams per ton, in rare occasions - as high as 151 – 177 g/t.

Thus, as we could see from this little geological information, there is a big number of gold-bearing alluvial placers with a high gold content in Svaneti. As noted above, according to the mythological, archaeological and historical information, mining of gold from the placers in Svaneti began in the prehistoric age and still continues in the present.

History and method of Alluvial gold mining in Svaneti region

As shown in the previous chapters, accounts of the alluvial gold mining in Svaneti are given in the written sources as ancient, as are those of the Antique Age. Greek historian **Strabo** (44 BC - 23 AD), wrote about Svaneti and its natives: “In mountain rivers of this country there is a lot of gold, mined by these barbarians using the perforated vessels and sheepskin” (Strabo, book-XII). **Pliny the Elder**, a Roman naturalist (23- 79 AD) wrote in his book *The Natural History*: “in Colchis who on finding a tract of virgin earth, in the country of the Suani, extracted from it a large amount of gold and silver” (Pliny the Elder, vol. 6). Interestingly, **Appian of Alexandria**, an ancient Roman historian (95 AD - 165 AD) writes in his 12th book *The History of Mitridate’s wars*: “many rivers carry invisible “gold sand” from the Caucasian mountains and residents put thick sheepskins into the springs and then collect precipitated gold”.

Although, from the antique period up to the 18th century there is no more information about Svaneti gold, medieval mine workings and jewelry workshops that exist in the region speak in support of the abundance thereof. About the same speak the wonderful gold artifacts of both ecclesiastical and worldly destination, crafted in Svaneti during the period in question. According to the historical sources of the 18th and 19th centuries, at that time, gold was being mined from alluvial placers in Svaneti. It is worth noting that, V. Goliev, a mining engineer found a gold nugget enclosed in a quartz matrix that weighed 365 grams, in the Svanetian village of Aci, in 1861.

Similar facts have been registered many times in Svaneti, what has naturally attracted a great interest of geologists and adventure seekers towards this area. In 1875-1877, S. Simonovich, another mining engineer has worked in the Enguri gorge. He made a conclusion later, that the placers between the villages Aci and Ifari were the richest of gold in Svaneti. Apart from the mentioned researchers, quite a few mining engineers

of the Russian Empire have been prospecting and washing gold in the river Enguri gorge and around it in the late 19th and early 20th centuries.

In 30-ies of the last century, in the days of the Soviet Union, gold production of an industrial scale began in Jvari placers of the river Enguri gorge, having lasted for 20 years. In the same period, gold was hand washed under the state control. In addition, the villages were instructed to mine gold for the country. It is known that a village has handed over 16 kg of gold during the month. Worth noting that, a 341 gram, 940 pure (up to 23 carat) gold nugget was found in the placer of Lasili in 1941.

At present, Svan locals continue washing gold from the mountain rivers in the same manner they did in the ancient times-with the use of sheepskins (Fig. 30; Fig. 31; Fig. 32) and special wooden pans (50 cm X30 cm) (Fig. 33). It is rather interesting that these pans differ from those used for gold panning elsewhere in the world - a clear evidence that the Svan pans have undergone an independent and long evolution.



Fig. 30. Svan gold washers with a virgin fleece in the river Enguri gorge.



Fig. 31. A sheepskin laid into the streambed and secured with planks.



Fig. 32. Washed sand in river Enguri canyon near village Lasili, where small size gold nuggets can be detected.

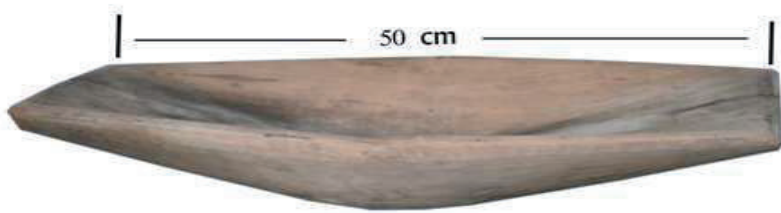


Fig. 33. A wooden pane of ash-tree from village Sgurishi (Upper Svaneti).

In Svaneti rivers, washed sand using sheepskins and wooden pans as a rule contains in high quantity different heavy minerals such as pyrite, magnetite, apatite and zircon; though in many cases golden nuggets are found there as well which are gathered in mechanical way. Natives of Svaneti know well where and when to wash gold. Beside the wooden pans they use sheepskins, putting them in the streambeds close to the gold-containing quartz veins, where the veins are being eroded by the streams.

Figure 34 shows a part of the Alibeg thrust zone, with quartz-arsenopyrite veins formed at the intersection of several faults. The concentration of gold is 30-80 g/t in this location. Below this fault zone, washed by the river Quani, gold has been spotted in the placer gravels. The gravels are presently being panned by the locals (Fig. 35). Notably, locals in Svaneti wash gold in many other gold-bearing placers too. As an example, Figure 36 shows the grain of gold found in the gold placer Mashrichala.



Fig. 34. Upper reaches of the river Quani and a part of the Alibegi thrust zone. Mamuka Narsavidze, a Svaneti local on the photo.



Fig. 35. Gold grains washed from the alluvial placers of the River Quani.



Fig. 36. Gold nugget found in the Mashrichala gold-bearing placer.

Thus, the recent geological studies of Svaneti have shown that gold is still abundant in this land, quite enough to provide grounds for giving birth to legends and to explain why this land is referred to as the "country rich in gold".

Finally, in the end of this chapter we would note that, in the 70-ies of the last century, a 278 meters high dam was built for a power plant in the river Enguri gorge, 50 km away from the Black Sea (Fig. 36). Sadly, the reservoir has blocked transportation of alluvial material by the river towards the sea, cutting off thereby the placers that are downstream the dam from replenishing their gold content.



Fig. 37. Dam of the Enguri Power Plant and a part of the water reservoir.

Microscopic study of alluvial gold of Svaneti Region

We have studied the alluvial gold samples and the gold-bearing ore of **Svaneti** microscopically, used both, the binocular and the polarized ore microscopes. Here, we will discuss only two samples, first one being the alluvial native gold grain from the river Quani gorge and the other - the gold-containing ore sample, taken from the Ieli placers, where gold stays associated with other minerals.

Under the binocular microscope the particulars look flake-shaped, flat crystals. Their color can be seen as both light and dark yellow, evenly distributed. The edges are rounded due to the low rigidity, with unveiled pulse marks on the surface. The particulars are probably? in the form of nugget gold, with the largest particular as big as 5 mm (Fig. 38). Under the polarizing ore microscope, a two-phase texture can be seen in the gold ore sample (Fig. 39).



Fig. 38. Image of alluvial gold nuggets under binocular microscope.

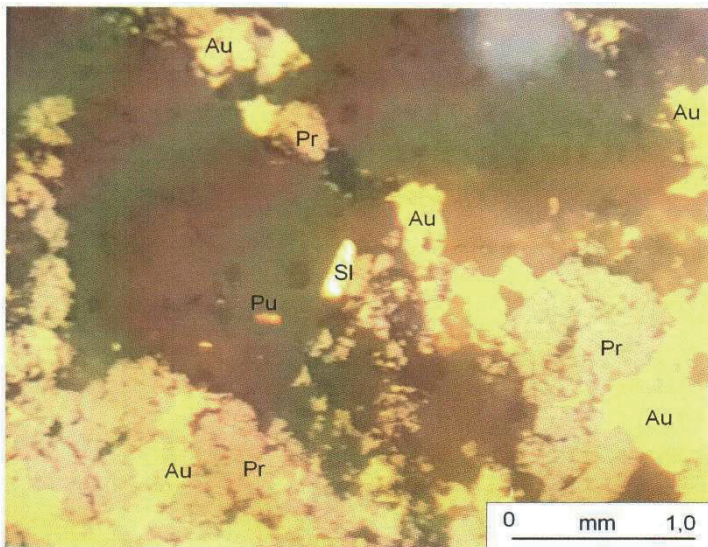


Fig. 39. Image of gold ore sample under the polarizing ore microscope.
(Au-gold; Pr-Pyrite; Sl-Sylvanite; Pu-Puristit).

The primary phase contains mainly large, pyrites without self-formation, whilst gold is contained in the secondary phase. A partial deformation has occurred on the first phase, resulting in the large pyrite particles shattered and the minerals that belong in the second phase, filling the forming gap between the particles. Besides, the pyrite crystallization has shown continuity, having had crystallized with gold in the formation process. The primary minerals are: Gold (Au), Pyrite (FeS_2), Silver Salts (Pyragirite- Ag_3SbS_3); Proustite – (Ag_3AsS_3) and Sylvanite – (AuAgTe_4). The reflectivity of gold is very high with the particle surfaces being clean and smooth and this property makes gold easily distinguishable from other minerals.

Under the microscope gold looked as: bright yellow or dark yellow color; particles without self-formation; rounding the shape of, or filling the voids between the minerals that originated earlier. Pyrite has been observed as having a dissipated form inside the gang, or as the groups with, or without a self structure. The pyrites that belong to the first phase have self-structured with rounded edges as a result of disintegration and are surrounded by a limonite shell. They have the shape of broken, granulated particles with the thin-middle particulars, dissipated in gang or ending the strip, with the size ranging from 0.01 to 0.08 mm. They are seen as a single particle with gold, or inside the gang.

Definition and distinguishing of silver salts (pyrargyrite-proustite) has proven very difficult, because of their extremely thin particles. They are observed as thin particles inside the quartz gang as closures of the gold. Their size varies between 0.01-0.1 mm. Sylvanite is found as few particles of 0.01-0.03 mm size, distributed inside the gang, or as closures inside the gold. It is observed as consisting of particulars without self-formation.

Thus, we can conclude that the sample is a gold ore. The primary minerals are: gold, pyrite and the pyrite disintegration products: limonite, pyrargyrite, proustite and sylvanite. The sample has a high gold ingredient and bears the features of the gold-containing hydrothermal quartz vein.

Findings of Remote Sensing of the Gold Occurrences of Svaneti

As known, in the modern research of the Earth Crust and the Atmosphere, the Remote Sensing is being widely employed (Schowengerdt, 2007 others.). The method allows obtaining information about objects and processes remotely, without physical contact or direct observation. In these particular occasions, data are being obtained through spectral analysis of images of the Earth crust, taken from aircraft.

However, alongside the multiple advantages, the method has some shortcomings. The advantage is that the method allows determining the presence of a chemical element through spectrum analysis of the weathering rind. The method cannot obtain any data in the cloudiness of over 2%; cannot work with the vegetation cover over 50%; with snow cover over 30%; with a gradient over 70 degrees, so on. Despite all these shortcomings, the method is undoubtedly innovative, for obtaining geological data from inaccessible and vast areas, in particular.

Remote Sensing of the territory of Svaneti was carried out by the **General Directorate of the Mineral Research & Exploration of Turkey**, commonly known as MTA, on request of the “Golden Fleece” Mining Corporation, to explore the mineralization of gold and other ores. To complete the task, data obtained from Terra ASTER Multispectral satellite was used.

The ASTER data have three types of spectral bands: VNIR (visible near infrared), SWIR (short wave infrared) and TIR (thermal infrared). During these analyses spectral bands have been used. The wavelength intervals of these bands are especially useful for determining the alteration minerals such as: alunite, kaolinite and phyllic alteration minerals (sericite, chlorite and epidote). The reason for the use of this mineral mapping technique is important in terms of revealing the environments of metallic minerals formation in the study area. The alteration minerals, in particular, give clues for detection of a metallic formation.

The data obtained by remote sensing for Svaneti confirmed the available information, and revealed new ore in some cases (Fig. 40 and Fig. 41). Maps clearly demonstrate that the region is rich in gold and other ores. Of particular interest are the remote sensing data for the detection of gold placers (Fig. 42).

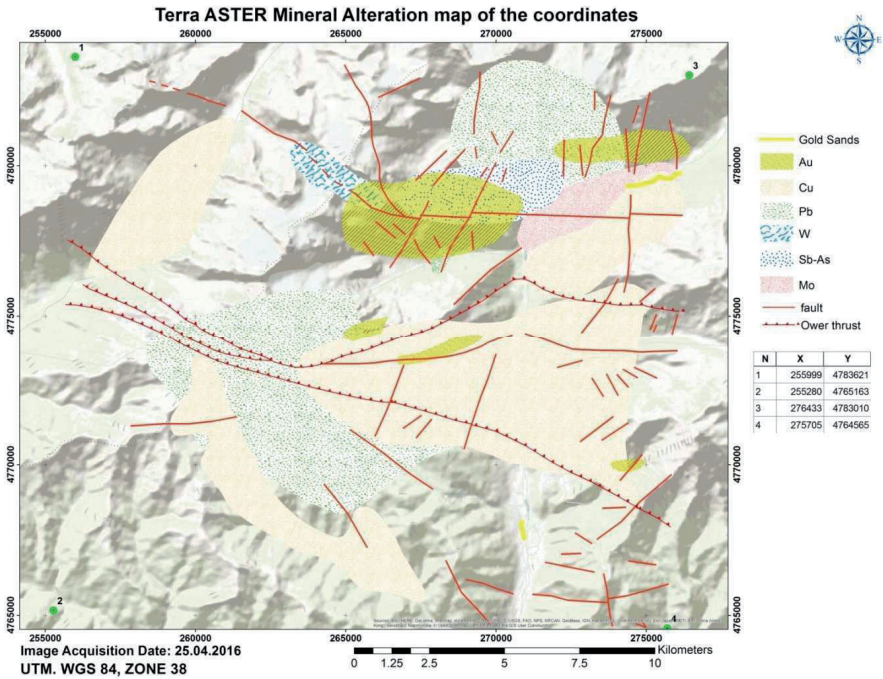


Fig.39. Remote sensing data of Au, Cu, Pb, W, Sb-As and Mo ore elements and the fault of the river Nenskra catchment (Chuberi community).

At the end of this chapter we should note that we did not consider it necessary for the purposes of this study to commit a detailed analysis of the remote sensing data for the Svaneti region. This method has given enough information about the main ore-fields of the region and confirmed the mythological, historical and also contemporary accounts of the alluvial gold-bearing placers of Svaneti, which is a very important argument for our research.

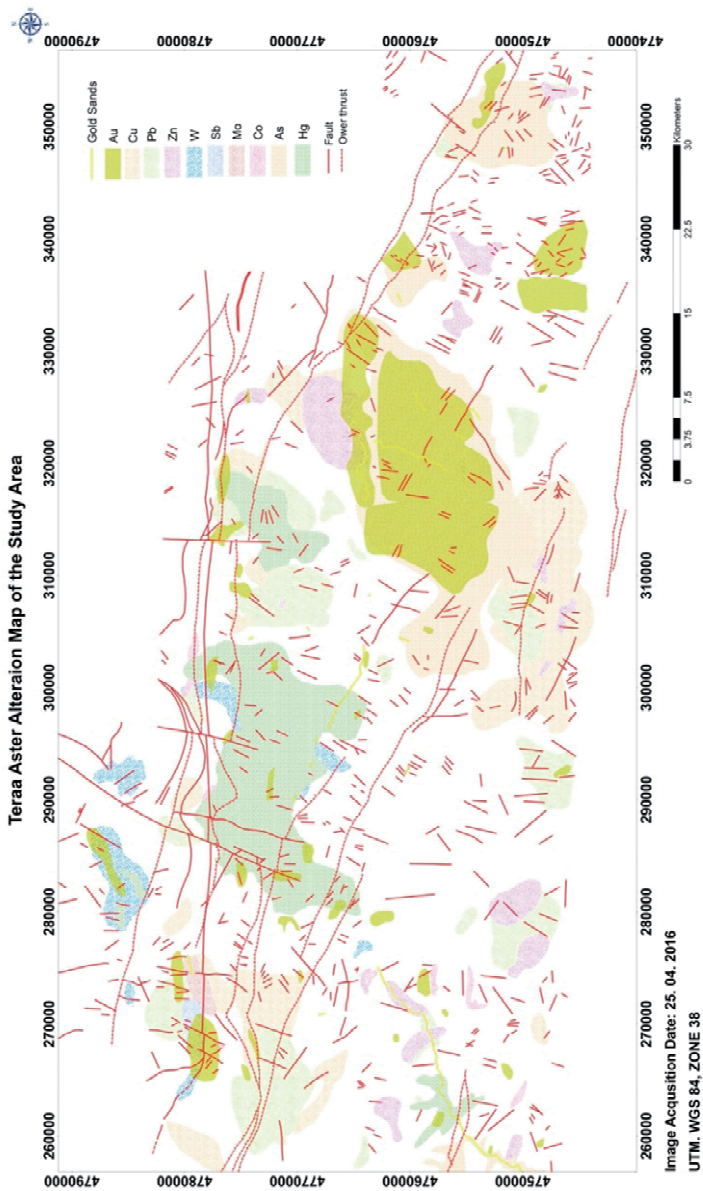


Fig. 40. Remote sensing data Au, Cu, Pb, W, Sb-As and Mo ore elements and the faults for the whole territory of Svaneți.

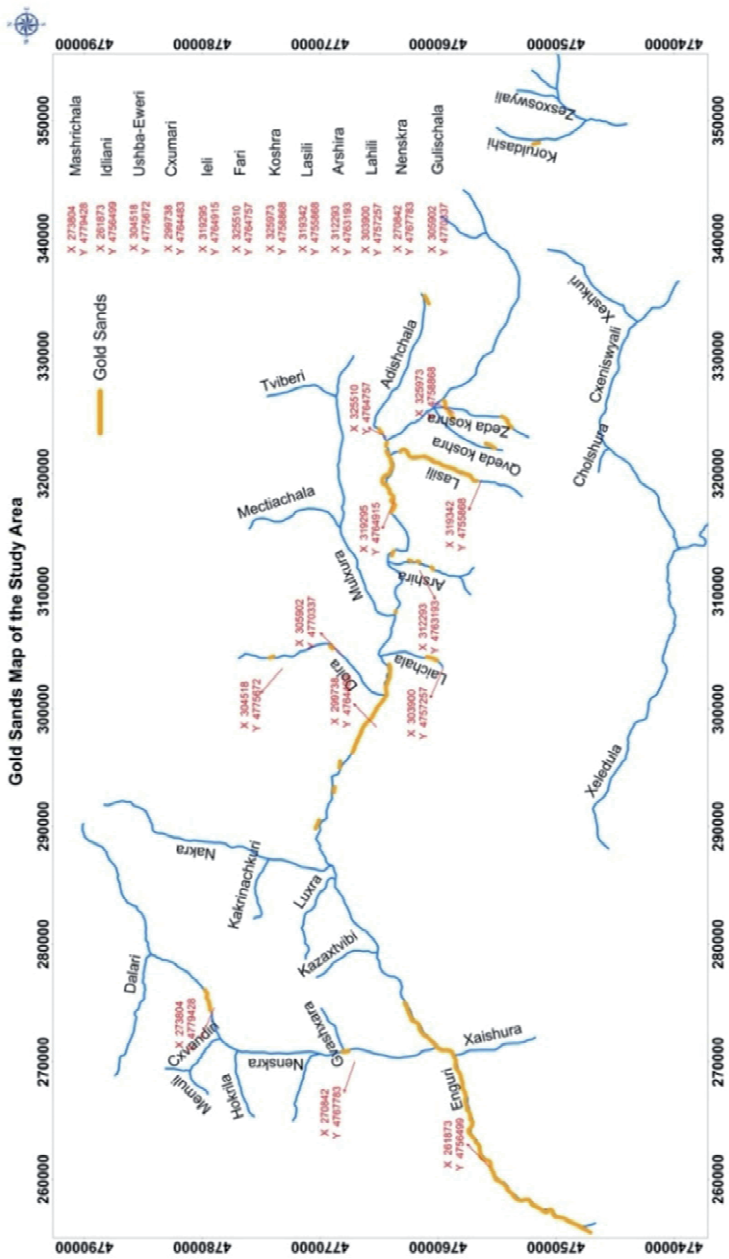


Fig. 41. Remote Sensing (Terra ASTER satellite) data on the gold-bearing alluvial placers of Svaneti.

Discussion

Thus, as we could see, the territory of the modern-day Georgia is a region where man has lived since the prehistoric times, whilst Colchis and Iberia were ancient Kartvelian kingdoms that have existed as separate until the 10th century AD, when they merged to form a single Georgian Kingdom.

Besides, the work has shown that the Gold Processing Technology has been highly developed in the both ancient Kingdoms, what gives the reason to suggest that the Gold Mining Technology should have been there to a standard as well. Based on the above, we can suppose that Argonauts may have indeed travelled to the Black Sea in the Early Bronze Age, to explore new lands, obtain Gold mining technology and other treasure in the ancient kingdom of Colchis.

The present paper, based on a multidisciplinary mythological-archaeological and ethnographic, historical and geological survey deals with the two contentious issues of the Argonauts legend: whether or not a voyage of Argonauts to the ancient kingdom of Colchis happened indeed and what was the actual value of the Golden Fleece phenomenon.

The country of Colchis described in the legend, according to historical records, in fact existed in the Bronze Age and was not a mere myth. There was a capital of the Aya (modern Kutaisi), and the river Phasis (modern Rioni). Besides, there was (and still is) a province of Svaneti in the kingdom of Colchis, where the rivers have been carrying down gold, whence the locals, according to historical sources, obtained gold with the use of sheepskins. Many think that the gold-bearing sheepskin represents the "Golden Fleece" in the legend.

In addition, in the 80-ies of the last century, Tim Severin, an English traveler and researcher, in his boat *New Argo*, proved that Argonauts should have been easily capable of reaching the Black Sea from the Aegean, putting an end to the claims that the journey should be just a myth.

Further, there is a clear imprint, both upon the ethnography and the archaeology of Svaneti, of the Argonauts trip and the Golden Fleece. In the excavations around the villages of Svaneti archaeologists have discovered numerous bronze artifacts, depicting a stylized symbiosis of sheep and ram's head. It should be noted that the theme of the Argonauts and the Golden Fleece is widely reflected in the Svan ethnography. The local elders are still firmly convinced that Argonauts have actually travelled to Svaneti. The Svan have been living here for more than 4000 years, due to what their legends and myths are rather reliable and often bear the imprint of real events of the ancient history.

The trip of Argonauts to the old kingdom of Colchis is widely covered in the writings of antiquity. The first reference to the Argonauts is given by genius Homer in his *Odyssey*, where he speaks about the expedition noting that this happened long before the Trojan War. As noted above, the theme of Argonauts in the Antique writing is so big and complex that can hardly be covered wholly. However, what is the most important for our research reads clearly in these sources, in particular: the most of the writings speak about the Argonauts journey as of an event that has really happened.

Beside the literature, Argonauts are broadly covered almost in all fields of the ancient art, which speaks in favor of this trip being more a reality than a myth. In addition, it should be noted further that almost 10 centuries have had passed between the Argonauts journey and the Antique Period. History, in the meantime, tends to be very forgetful, as we know, and a heroic feat that really happened may well have turned into a legend as the time passed. We should add here that, Schliemann has effectively proven with his discovery of the Troy that Homer has been speaking truth. Why can't we trust the genius poet with his tale of the Argonauts, then?

Interestingly, in the archaeological papers published in recent years, authors suggest that ancient Iberia might have been the land of the Golden Fleece instead of Colchis, since according to the papers, there should have been mines in the kingdom of Iberia about 5000 years ago, where gold was being mined from bedrock deposits, not placers

(Stollner et al., 2008; Hauptmann, Klein 2009; Stollner et al., 2014). The authors claim that exactly the huge gold mined there has laid the grounds to the legend about the land of the Golden Fleece. In our opinion, though, gold mining in these mines is rather questionable, as is the carbon dating thereof. What is beyond any doubt is that, by all geological and mining parameters, in the Bronze Age, gold could have been extracted by men only from placers that contained loose, exzogenic gold and by no means - from the hard rock ores of hydrothermal origin (Okrostsvavidze, 2016).

As to the geological part of the research, we decided to study the territory of the ancient Colchis kingdom geologically, in order to find the areas where mining of gold from alluvial placers could be possible i.e. a place where the Argonauts could have extracted gold and come to know the ancient mining technologies of this particular region. Our work has confirmed that Svaneti is, uniquely, a region of the ancient Colchis Kingdom, where mining of gold from alluvial placers could be possible and where the locals still wash gold from alluvial placers through modern domestic, wooden vessels or pans with holes.

At the same time, however, the present-day intensive erosion cycle caused by: 1) abundant modern precipitation as well as the 2) extensive glacial melting into the affluent hydrological network and 3) rapid uplift of the Svaneti segment of the Greater Caucasus, have all promoted the fast replenishment of gold content in the present-day river placers. The concept of the ongoing active enrichment of the stream gravels can be seen as a geological argument in support of high level of gold mining activity in the historical past as well as today.

Remote Sensing of the territory of Svaneti, carried out within the frame of our research, confirmed the available geological data on the rich gold presence in the region. The Remote Sensing data proved particularly interesting for identification of gold bearing placers. The study confirmed existence of old, geologically known river placers with high gold content and also discovered new ones.

Thus, the recent geological studies of Svaneti support the claims that gold is abundant in this area and that its content in the river gravels is high enough to give birth to legends and describe the region as “a land of gold”. Further, the geological data obtained by our team in Svaneti, seen as a response, supports the idea that: "the country of the Suani" as referred to Pliny the Elder and other ancient sources, is the modern-day Svaneti, not another province of the ancient Colchis kingdom.

The newly obtained geological data brought significant amendments into perceptions about the Argonauts time too. As discussed above, the myth of the Argonauts was born in the time of the Minoan civilization (Aegean Bronze Age Civilization), which, as known, developed during the early Bronze Age, around XXV - XV century BC (Bennet, 2003) and was suddenly destroyed in XV century BC (Castleden, 2005).

Decline and subsequent disappearance of this civilization the modern scientific research links to the activity of Santorin/Terra super-volcano (Balter, 2006, etc.). According to the study, a powerful explosion of the volcano caused catastrophic earthquake and tsunami destroying the Minoan civilization that prospered along the Mediterranean at those times. Interestingly, some researchers link the catastrophic explosion to the biblical Flood, whereas others - to the disappearance of the mythical Atlantis.

The Santorin/Terra super-volcano locates 70 km to the NE of Crete Isle. There are historic reports about the activity by the volcano repeated multiple times (197 BC, 46, 726 AD, so on); however, the precise date of the final catastrophe is still disputable. By the chronicles of Ancient Egypt, the eruption occurred in 1500 BC (Warren, 2006); in 1645 -1600 BC - by carbon dating (Manning, et al., 2006), whilst by the micro Rb-Sr dating, it happened in the interval of 1470-1480 BC (Goldschmidt 2013 Abst., 2013). As we can see, the data are scattered in time, but for our research it is not essential. Generally, we can suggest that the explosion occurred between the 16th and 15th centuries BC. As discussed above, by origin, the Argonauts were Minoans

(Minyans), who, according to the “ Histories “ by Herodotus settled on the Santorin/ Terra Island on by BC 800, what suggests that they had previously lived on a nearby island.

Based on the above, we tend to think that Argonaut’s expedition happened before the catastrophic blow up of the Santorin / Terra super-volcano, since such blowup would be particularly damaging for Minoans and they could have no longer been capable of such a large-scale expedition.

In the end of the discussion, we should note that one of the arguments, according to which the scientists believe that the Argonauts trip to the kingdom of Colchis is a myth and not a reality, is that there are no structures or ruins left to prove the existence of powerful kingdom of Colchis in the XV-XVII centuries, BC.

Logically, since the Caucasus is a young orogenic system, where many natural disasters have taken place, we admit that one or more of such events could have caused destruction of all physical evidence of the culture of ancient Colchis. Further, we should also take into account high probability of numerous wars and destruction that the ancient kingdom of Colchis had to experience, whereas each of these were easily capable of obliteration of the Colchian cultural heritage.

And finally, it is also possible that the ancient Colchians used to build only wooden structures, since the timber was available in great abundance.

Summary

Based on the analysis of our research, we think that a harmonious sequence of the mythological, archaeological, ethnographic, historical and geological data clearly demonstrates that the heroic journey of the Argonauts to the ancient kingdom of Colchis was a true historic event that later became shrouded in legend.

The main objective of the trip was to get hold of the treasure of the kingdom of Colchis and learn the technology of gold extraction from the river placers. As an extra task, they had to also discover and explore new lands. Expeditions from the Aegean to the Black sea like this one, should have been rather common in the Early Bronze Age, since later, a massive colonization of the Black sea coast by Greeks took place. We think that it might have been a mission with the objectives similar to those of the expedition of Hernán Cortés, the Spanish Empire sent to Central America in the early 16th century.

If we look at the existing historical, ethnographic and archaeological data, Svaneti is the province of Colchis, where the Argonauts were heading. The same is confirmed by the available geological data, since Svaneti is the land where it was (and still is), possible to wash gold from the river sands. Most likely, the Argonauts have travelled to Colchis before the eruption of the Santorini/terra super-volcano (16th-15th century BC) that destroyed the Aegean civilization of the Mediterranean. We think that since the Argonauts were representing this civilization, after the catastrophe they were in the least likely capable of carrying out an expedition of this scale.

As concerns the Golden Fleece Phenomenon, the theme, as we know, is still disputable despite numerous published papers. Initially, it should have had a symbolic meaning of gold mining technique with the use of sheepskins; In the Antique period, which is widely considered as an era of myths, more than 10 centuries after the Argonauts voyage, the Golden Fleece became a myth; In the Middle Ages, when knighthood was the greatest among the virtues, the "Golden

Fleece" became a symbol of the knighthood and strength; during the Renaissance, when wealth was the greatest of the goals for the noblemen, it stood for the wealth; In the modern era, the "Golden Fleece" phenomenon is again a subject of discussion and one of the main objects in the research of the Aegean civilization of the Bronze Age.

Afterword

At the end of this book, I would note that at present, almost on all the territory of Upper Svaneti permits are issued to various companies in the gold mining industry that are working with the both, the main ore and the gold-bearing placers. In one occasion, a foreign company began gold mining from the Ieli placer in 2015, but had to halt the operations because of the strong protests from the local population. The reasons of the protest are diverse: for some of the locals, gold panning is the only source of income; others see the industrial mining as an unacceptable violation of the traditional, centuries-old harmonious lifestyle; still others are worried about the environmental problems that arise from the mining activities.

It is very difficult to answer the question: what is the better option for this unique corner of the Caucasus, proceed with the mining industrialization, or leave the things the way they are, that is to say - primitive. For me, as for a separate individual, the latter option is more acceptable. However, only the future will show what becomes of the "country rich in gold" which is believed once was the destination of the heroic voyage of Argonauts.

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