GeoMedicine Seminar

Vienna, November 16th, 1999
Baden, November 17th, 1999

Geological Survey of Austria
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ABSTRACTS AND FULL PAPERS

GeoMedicine Seminar Vienna – Baden, November 1999 – Berichte der Geologischen Bundesanstalt, ISSN 1017-8880, Band 50, Wien 2000

Wolfgang MARKTL

GeoMedicine in the Interdisciplinaric Field of Reserch – Possibilities in Austria

Abstract

Geomedicine may be defined as mutual influence of geological or geographic factors and the health of people respectively. Environmental influence may arise from the ground, underground or from the air. In every case, the influence from the environment on the health may be positive or negative. From the standpoint of medicine the main interest is directed obviously to the influence of environmental factors on the health. In other disciplines however, also the influence on environmental factors exerted by men is of interest. Medical disciplines interested in geomedicine are for instance bioclimatology, balneology and nutrition. With regard to the possible consequences of geomedical influence on health several examples can be illustrated. Bioclimatological influences for instance may be detrimental for the life of people, on the other side however in many European countries like Austria, Germany or in Switzerland climatologic factors are the basis of climatotherapy performed in climatic health resorts. Geomedical factors arising from underground are important in balneology. The composition of healing waters is dependent on hydrogeology circumstances. This is true for chemical elements or compounds which are essential for the healing power of the water as well as for contents with adverse effects on the organism. In balneology also muds, called peloids, will be applied. These peloids are defined as anorganic or organic material arising from geological or geological-biological procedures. Mineralized waters can be used as healing waters but also for drinking purposes. With this example a connection to nutrition appears. As with water also the composition of food is dependent on geological factors. This is true mainly for anorganic contents but has also influence on the organic compounds found in living organisms.

Geomedicine may be defined as mutual influence of geographic or geological factors on the one and the health of the people on the other side. In another sense, geomedicine is defined as the science dealing with the influence of ordinary environmental factors on the geographic distribution of health problems in man and animals. These definitions exclude medical problems caused by artificial or man made factors respectively. Generally it has to be considered, that factors from the natural environment may health promoting or detrimental for the health status of individuals.

By using the word geomedicine geochemical and geophysical factors are included. Therefore many scientific disciplines are involved in the geomedical research efforts. From the medical standpoint geomedical questions are of interest in nutrition, bioclimatology, balneology, chronobiology and so on. In the following, some examples of geomedical problems should be presented. In the field of nutrition especially the content of minerals and trace elements in the food is of interest. It is a well known fact, that there maybe great differences in the content of minerals and trace elements in food of plant origin. This food is the basis of human nutrition but also for animals. Because animals eat vegetables, also the content of minerals and trace elements in animals is dependent on the content of the plants eaten by the animal. In this way the alimentary supply of man with the essential nutrients mentioned before is dependent on the chemical composition of the upper layers of the earth. Some examples of geomedical problems in connection with anorganic micronutritients are the health consequences of the alimentary supply with iodine, magnesium or selenium. In case of iodine, it is a well known fact, that in all continents of the earth a deficiency status concerning this trace element is prevalent in regions far from the coast. The reasons for this fact are also well known. Several countries undertake efforts to improve the nutritional iodine status by iodizing foodstuffs like table salt (as in middle european countries) or oil (as in south America). On the other side it is not a common knowledge that several mineralised waters exhibit remarkable amounts of iodine, as can seen from the example of bottled natural waters from Austria. This fact, that waters arising from deeper layers underground contain several minerals and trace elements in amounts with importance for the alimentary supply is a typical problem of geomedicine. This is also true for magnesium. Another example however is selenium. The concentration of selenocompounds in water is generally low and therefore also drinking mineralised water cannot contribute to the improvement of

the nutritional status with this chemical element. The content of selenium in unprocessed foodstuff however is extremely variable. So we can find regions with very low selenium contents of the ground and therefore also in food with the consequence of a higher risk for an alimentary deficiency pertaining to this trace element. On the other side however there are other regions with very high selenium content of the soil with the consequence of a possible poisoning by eating natural food.

The chemical composition and physical properties of water are of interest not only in nutrition but also in balneology. For the health power of water hydrogeological factors are of decisive importance. This is true not only for the contents of solids but also for gases like CO_2 and radon as well as for the temperature of the water.

The availability of minerals and trace elements for the plant is also dependent, at least in part, on climatological influences. Climatic conditions like temperature, precipitation, wind and air humidity exert their influences not only on the chemical composition of plants and on the availability of several chemical compounds, but these are also geomedical factors as such. Of course, climatic conditions are dependent on geological and geographic factors. Like other geomedical influences also climatic factors can be of positive or negative value for the human health. The possible adverse effects of certain climatologic influences like temperature extremes are evident and it is not necessary to discuss this in detail. It is, however, less well known, that climatic factors can be used as remedies for health. Climatotherapy as performed in climatic health resorts is therefore another field of geomedicine.

At least, also chronobiology can be included into geomedical considerations. The human, like all living organisms can be considered as rhythmic organized organism in a rhythmic organized environment. Rhythmicity is an inborn property of all living organism. The measurable appearance of this endogenous rhythms however is influenced by rhythmic influences from the environment. By far the most important influence in this regard is the rhythmic change of light intensity during the 24-hour period. Light intensity and duration of the lighting period are themselves dependent on geology and geography, at least in part.

In this presentation I have tried to give a short overview over the manifold faces of geomedicine. Geomedicine is a multidisciplinary field and research progress is only possible, if scientists coming from different scientific disciplines are working together.

Name of bottled mineral water	Calcium content in mg/l	Name of bottled mineral water	Magnesium content in mg/l	Name of bottled mineral water	Iodine content in µg/l
Margarethenquelle (Astoria)	285,6	*Long Life*	197,4	*Martinsquelle*	270
Long Life	263,4	*Gleichenberger Johannisbrunnen*	111,2	*Vitusquelle*	160
Martinsquelle	262,9	*Margarethenquelle (Astoria)*	110,2	*Gleichenberger Johannisbrunnen*	160
Juvina	255,7	*Martinsquelle*	90,7	*Riedquell*	86
Preblauer Auenquelle	251,7	*Riedquell*	83,4	*Alpquell*	84
Riedquell	234,1	*Römerquelle*	77,9	*Sulzegger Styrianquelle*	60
Alpquell	224,4	*Juvina*	57,9	*Preblauer Auenquelle*	57
Gleichenberger Johannisbrunnen	175,2	*Preblauer Auenquelle*	55,0	*Güssinger*	50
Römerquelle	171,1	*Peterquelle*	44,0	*Margarethenquell (Astoria)*	50
Peterquelle	160,2	*Vitusquelle*	41,1	*Markus Quelle*	36
Güssinger	117,3	*Vöslauer*	39,2	*Juvina*	26
Vöslauer	98,2	*Alpquell*	39,1	*Long Life*	23
Markus Quelle	96,2	*Markus Quelle*	34,2	*Römerquelle*	14
Frankenmarkter	78,2	*Güssinger*	26,4	*Peterquelle*	14
Vitusquelle	63,9	*Sulzegger Styrianquelle*	7,0	*Frankenmarkter*	11
Sulzegger Styrianquelle	38,9	*Frankenmarkter*	5,0	*Gasteiner*	5
Gasteiner	15,2	*Gasteiner*	1,0	*Vöslauer*	3

Tab.1: Concentracions of Calcium, Magnesium and Iodine in botteld mineralwater

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Bjørn BØLVIKEN

Associations between Diseases and the Natural Environment

Abstract

Many associations between occurrences of human diseases and qualities of the natural environment have been identified. Search for additional associations of this type may lead to new hypotheses for risk factors in endemic diseases with incompletely known aetiology. Geochemical maps show that systematic natural dispersion patterns with high contrasts exist at all scales from local to continental for many chemical elements providing an interesting material for comparisons of epidemiological and environmental data.

The paper demonstrates two geomedical examples, one from China and one from Norway. In China, inspection of maps uncovered that exceptionally high rates of *nasopharyngeal carcinoma* in the south eastern part of the country are associated with high contents of U and Th as well as low contents of Mg, Ca and Sr in soil. In Norway, application of a new method for spatially moving correlation analysis disclosed that in Southern Norway high rates of *multiple sclerosis* are associated with high contents of Rn in indoor air as well as with low atmospheric fallout of marine Mg. No similar associations were found in Northern Norway. Based on these data it is suggested that Rn or other radioactive elements may be risk factors in both *nasopharyngeal carcinoma* and *multiple sclerosis*. Development of increased levels in soils of Ra^{2+} - which by radioactive disintegration is a progeny of Th and U and a precursor of Rn - may perhaps be counteracted by ion exchange with Mg^{2+} at rates which increase with increasing Mg supply.

The data indicate that ecological studies in epidemiology should preferably be carried out by comparing maps or by spatially moving statistical analyses, since geomedical associations may vary geographically and in a non linear manner. There are many possible mechanisms explaining links between occurrences of human diseases and environmental factors, of which the possibility of reactivation of latent virus by natural ionising radiation, seems to be of special interest in connection with the diseases studied here. The paper concludes that ecological investigations have a great potential for obtaining interesting geomedical results in epidemiology.

Sepp PORTA

Magnesium-Catecholamine Interaction in Stress

Abstract

Magnesium availability in food gets more and more restricted because acidic rain depletes it from the upper strata of the soil, so that ist uptake by plants gets smaller. This seems to create a limiting step in glycogenolysis and gluconeogenesis in man and animal, whereby increased sugar demand in stressful situations is only slowly met, because Mg is necessary for most of enzymatic katalyses in those processes. A field experiment should underline those assumptions:

Since we could show (Porta et al. 1997), that some effects of catecholamines, like changes in base excess, are linearly proportional to catecholamine levels, we used them as screening parameters. By measuring 10 different, stress related parameters, we were able to get a whole pattern of the effects of stresses of different intensity and duration in the more or less immediate past, underlining the important role of Mg in stress.

Material and methods: Of 26 young volunteers on national service 50 µl of capillary blood were taken just after light gymnastics and 3 minutes of jogging. Bicycle ergometry up to 200 watts (post stress provocation test, Porta et. al. 1993) was superimposed immediately, followed by a second blood sampling for determination of electrolytes, blood gases and lactate. A group of 20 more volunteers who did not undergo immediate previous stress, but sleep depriving night exercises followed by a field combat maneuver some hours beforehand, underwent the same procedure.

Most important results and conclusions: Ionized Mg was low in the first group and much higher in the second group, a feat not due to diet but to previous stress. Linear correlation between the parameters were the more plentiful, the higher the intensity of accumulated stress has been. Moreover, characteristic stress related interparameter correlation pattern (ICP) evolved, whereby Mg played an important role. Consequently, we formed 3 new subgroups, regardless of the previous workload, only characterized by the fact, of an increasing or decreasing or stable reaction of ionized Mg to the ergometric test. Average values, correlation numbers and ICPs pointed to the fact, that the increasing Mg group consisted mainly of subjects in a significant better bodily shape than in the decreasing group.

Jurian HOOGEWERFF, Iris BUXBAUM and Gerhard HEISS

First Attempts Towards Geochemical-Epidemiology in West Austria

Abstact

In a recent publication (1) spatial data for cancer morbidity and mortality in West Austria was presented. Intuitive observations of the published maps led to the hypothesis that the geology or geochemistry in western Austria might have an influence on the health of the inhabitants.

In recent years knowledge about the importance of trace elements in nutrition and health has motivated environmental geochemists to compare spatial geological data with spatial indicators of health (2). The Austrian Geochemical Stream Sediment Atlas (3) provides the most densely sampled indicator of the geological and anthropological "background" presently available in Austria.

In our study we compare the spatial distribution of different standardised cancer morbidity rates in the states of Vorarlberg, Tyrol and Salzburg with the those parts of the Geochemical Stream Sediment Atlas of Austria which have been completed until today (the "Central Zone") in that area. The completion of the coverage over the whole of Austria is in progress and expected to be ready in 2005

The major problem in comparing spatial epidemiological data presented in political areas with geochemical point data is finding a common format.

In a methodological pilot study we are testing two different approaches:

In the first method the data are transformed to a rectangular grid using a weighed inverse distance or kriging algorithm for the geochemical data and a simple rastering of the political boundaries to the same grid format. The two grids are then compared using a moving (3x3, 5x5 or 9x9) correlation window giving a correlation coefficient at the central cell. A problem is the determination of the optimum cell size for the epidemiological data. Small cell sizes produce large areas of constant values within large political districts which, when using parametric correlation, produce artificial correlation in these large districts (Figure 1). An alternative is the use of non parametric correlation.

In the second method the geochemical data are translated to the political areas using either the median, 95 percentile or maximum value of geochemical data within one political district. Although non spatial correlation analyses is now easy spatial correlation of non rectangular irregular areas is notoriously difficult. We hope to present the first results of non linear correlation analyses at the meeting.

References

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(2)...BØLVIKEN B., NILSEN R. and UKKELBERG A.: A new method for spatially movingcorrelationanalysis in geomedicine, Env. Geochem. Health: 19, 143-153 (1997)

(3)...THALMANN, F., SCHERMANN, O., SCHROLL, E., HAUSBERGER, G.: Geochemischer Atlas der Republik Österreich 1:1 Mio. - Geologische Bundesanstalt, Wien 1989

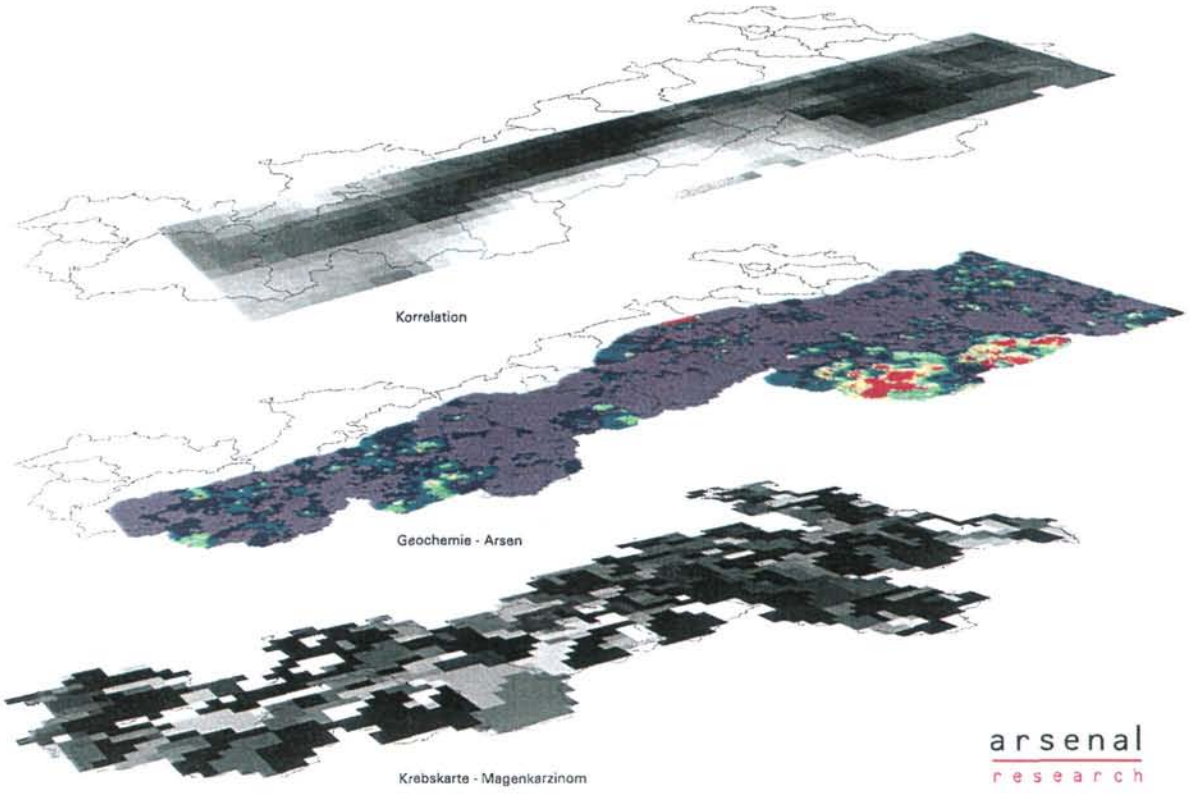

Fig 1. Example of the influence of large political districts (lower layer). In a parametric window correlation method between lower cancer rates layer and middle geochemical layer artificial correlation is produced (white cells in the upper layer) in these districts.

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Walter KOLLMANN

Mineral Waters – Key to Health and Advanced Cultures?

Abstract

"Water loading" is not only a modern term, but was already in former times ("Trinkkuren") a physiologically important preventative cure method for health maintenance.

Searching for hydrogeologic investigations in Greece to the Middle East and by visiting cultural sites of antike Greek artists and sportsmen in Athens, some comparisons obviously were evident with the local aquifer-well drinking-water chemistry (espec. Magnesium and Potassium content) of other main cultural sites like f.e. (alphab.): Babylon (Iraq), Byzanz (Turkey), Gizeh (Egypt), Jerusalem (Israel), Petra (Jordan) or Rome (Italy) with similar paleogeografic genesis of the groundwater bearing sediments. From all these the former people get their drinking water by local wells dug in marine evaporitic derived mineralized sediments with high content of $MgSO_4$-mineralization, i.e. solution by similar sedimentation cyclus and thus aquifer typus. Several sites named Magnesia are well-known SE Larissa and twice near Izmir (Smyrna, Manisia, Ephesos, Bodrum = Halikarnassos).

By drinking that high concentrated magnesium complex, medical reactions derive some proper oxigen-consumption for the human blood causing a better supply of brain, heart, nerves and muscles, hence improving the intelligence and health of human beings. Simultaneously the Sulfate consumption causes a better digestion and metabolism. Although these effects and additionally Fluoride, Iodide, Lithium, Magnesium, Potassium, Strontium causes the reaction: "mens sana in corpore sano ....." and might be the reason, that these former antike people were able to create their famous cultural development, quod erit demonstrandum by further interdisciplinaric geomedical-hydrogeologic investigations, which had been done by some local groundwater analysis (espec. F, K, Li, Mg, Sr), because improved bioequivalence by "water loading" is a fact.

These shallow groundwaters are slight bitter mineral waters, which were used exclusively in former times, caused probably health, high motivation for cultural aspects and geogene originating intelligence. Austrian mineral waters too, like the spa (salus per aquam) Bad Radkersburg named "Longlife" (nomen est omen?) or the "Purgina" are enriched with Mg. But too much causes severe renal failure by Hypermagnesemia, whereas a moderate (< 29 ppm Mg, for therapeutic application 67 - 134 ppm/day) consumption by drinking water improves statistically brain performance, concentration, stress tolerance and decreases blood pressure, myocardial infarct risks, neuromuscular hyperexcitability, asthmatics, cerebrovascular and total mortality.

Further on it is interesting that such salts were used as cathartic drugs by priests during Renaissance times in Italy, as one might assume causing the origin of holy sites, like Assisi, Loreto, Lourdes, Mariazell, but also Canterbury, Glastonbury, Stonehenge, Tschenstochau, Salt Lake City (Mormones) or the river Ganges. Additionally improving also artistically abilities and faculties as known from sea coastal regions f.e. in the Netherlands (Rembrandt, Rubens etc) and the Toscana (Leonardo da Vinci, Michelangelo etc) would be imaginable by drinking that waters with more than 200 ppm Mg. Maybe that the colossus of Rhodos has been built by euphoria caused by to much intake from mineral water springs over there.

By the fact of actual existence of the local aquifers, already now available for sampling, the scientific argumentation by hydrogeochemistry in-situ-analysis of local domestic wells should be improved and manifest that hypothesis, hoping that GeoMedicine help to prevent from drugs and conduct to global social and economic progress

"hydor men ariston"

"water is the best"

(quotation after PINDAR)

Having read at a well for water drinking cures on the island Kos (birthplace of HIPPOKRATES)
dedicated to HYGIEIA - the Greek goddess for health

1. Introduction

1.1. Historics

The great Greek philosopher THALES from Milet (625 - 545 B.C.) concluded that water is the ultimate substance, the principle or element of all things (PERKOWITZ, 1999). A century later, when the Greek philosopher EMPEDOCLES (490 - 430 B.C.) proposed that the complexities of creation required four elements instead of one, the liquid state took its place among them as the element water. Since him, who was as a philosopher of nature interested in the development of life, the the human physiology and the entire universe based on that fundamental substances. But reduction to only 4 elements: air, fire, soil and water has been overcome since BOYLE (17. century), who developed, besides the physical conditions of gases, the first atomic-theory as a basis of chemical elements (Periodic System). EMPEDOCLES yet indicated by his interests in essential parameters of life the high intelligence of that great Greek (Agrigent was a former Greek colony in Sicily, which is formed by volcanic and other Magnesium-enriched rocks, like dolomites and also potassium salts).

Nevertheless another Greek - called: "smiling" - philosopher DEMOKRIT (460 - 370 B.C.) created the first theory of the atomic structure. Even the term "Atom" derives from the Greek language and means "not divisible". Maybe the intuitive ability of that rational thinker, who was born in Abdera was improved by his travels to Egypt and other main centers of culture in the Near East

The founder of philosophical tradition in human-medicine was the famous Greek HIPPOKRATES (460 - 375 B.C.) on the island Kos. Perhaps triggered by a lot of minerals in the marine salt, fish-food and liquids around, his idea that medical doctores should study the environment of their patients sounds quite actual and should be a hint for more interdisciplinaric cooperation between medicine and geosciences.

ARISTOTELES (384 - 322 B.C.), born as a medical doctor's son in Stagira (NE Greek) collected systematically facts concerning nature and human life and founded the first Geo-Bio-encyclopaedia.

1.2. State of science

Natural water is by far the most important, for the scientific consensus is that life could not exist without it (PERKOWITZ, 1999). Its central role in life arises because water is a prime natural medium for chemical reactions. Its mobile molecules act to diminish the electromagnetic forces that link atoms together, freeing the atoms to combine chemically with other free-floating atoms. According to present thinking, only a watery environment such as the sea could have supported the chain of chemical reactions that formed such elaborate compounds as Chlorophyll, DNA and hemoglobin, thus the presence of water and its mineralization is once more essential for all the ongoing chemical processes of life.

Unfortunately in the mediterranean and semiarid climate and marine geological environment generally the groundwater is scarce and mostly strong mineralized. Because of the content of certain essential minerals deriving from the adequate, somewhere evaporitic influenced salty mineralized sediments, high contents of essential elements like F, J, K, Li, Mg, Mn, Mo, Se, Sr, Va, Zn etc (GRUBER, 1998) can be expected. Especially the $MgCl_2$- and $MgSO_4$-mineralization (i.e. solution by groundwater of similar sedimentation cyclus and thus aquifer typus) may perhaps cause some proper oxigen-consumption for the human blood causing a better supply of brain, heart, nerves and muscles, hence improving the intelligence and health of human beings. Simultaneously the Sulfate consumption causes a better digestion and metabolism. Although these effects the reaction: "mens sana in corpore sano ....." and might be the reason, that these former antike people were able to create their famous cultural development.

It might be an interesting thesis to investigate the sites of the ancient sports-stadions concerning their local groundwater, which had to be used for drinking by the former sportsmen (Olympic games), because of improving proper muscles activity by Magnesium which now is applied as a quasi legal doping.

Tab. 1 presents some results of hydrochemical groundwater-analysis from Athens, Rhodos, lower Egypt, in the Jordan valley, E. Petra as a first step of further interdisciplinaric geomedical-hydrogeologic investigations, quod est demonstrandum (EDLINGER & KOLLMANN, 1997, 1998). These have been done by some local groundwater analysis (espec. F, K, Li, Mg, Sr), because improved bioequivalence by "water loading" is a fact (GRIMM & NOWITZKI-GRIMM, 1999).

2. Theory

Being creative, healthy and sane (ZIRM, 1995; MARKTL et al., 1996) - because of living in a salt-enriched evaporitic environment with much Magnesium (see Tab. 1: Egyptian-, Greek-, Jordan-people and others like i.e. the Mayas in Merida, which is supplied with 311 ppm Mg; whereas in common continental water supplies Magnesium is generally only <20 ppm) - people seem to were able for constructing advanced and most exceptional cultures.

Locality	Mg	Sr	K	Li	F	SO_4
Rhodos Soronis (Greece)	100	0,17	3		0,12	37
Rhodos Sakalou	57	0,21	1		0,42	38
Bodrum = Halikarnassos (T)	47		10			
Athens Metro S. Akropolis	30	0,01	240	0,07	0,41	365
Athens National Garden	29	0,49	3	0,02	0,40	76
Dilessi - Schimatari	62	0,9	1	0,07	0,53	33
Ilia drilling (a)	215	27,2	192	2,76	30	790
Ilia drinking water supply (b)	27	0,01	1	0,01	0,04	13
Edipsos Spring "A"	338		503	0,56		1111
Edipsos Thermae Sylla (F3)	242	11,2	260	0,93	50	990
Edipsos drilling Ipokrates	300	15	330	1,25	40	1100
Edipsos drilling Artemis	295	14,8	335	1,33	50	1130
Edipsos drinking tap "C"	45		103	0,14		83
Kamena Vourla "A"	263		164	0,46		714
Kamena Vourla Koniavitou "B"	191		173			511
Kamena Vourla Asproneri "C"	33		1			7
Dead sea (Jordan)	more Mg than Ca, more K than Na					
Jordan valley Karameh	304		25			259
Tell Asaidyeh	107	2,75	21	0,06	1,02	122
Pella	30	0,52	3	0,01	0,45	33
Berg Nebo Moses-Qu.	29	0,56	2	0,01	2,7	27
Hammamat Ma'in Therme	31	3,80	44	0,26	1,85	210
WV Amman Qasr Amra	51	4,95	10	0,03	15,8	365
Shomari Reservat	57	5,95	17	0,03	19,5	420
Al Jafer (E. Petra)	443		23			302
Jerash = Gerasa	68		49			538
Merida (Mexiko)	311,2					
Gr. Bitter Lake (Suez - Egypt)	1146					
Ismailia Artesian well	48	0,97	9	0,04	0,34	615
Luxor - Karnak "Holy well"	85	0,86	118	0,01	0,08	356
Luxor - Karnak "Holy Lake"	73					
Memphis Museum Ramses II	40					
Memphis well	52	0,79	13	0,01	0,12	165
Sakara Farm - Restaurant	64	0,97	7	0,01	0,14	310
Siwa (Roman spring)	83,2		40			282
Ain Dakrour	65,1		28			274
Ras el Hekma	62,7		29			358
Ayoun Musa	102,5		70			446
Purbach "Purgina" (Austria)	1974	2,6	30	1,6	0,18	11647
Spa Radkersburg "Longlife"	202,1		9			8

Tab. 1: Essential mineralizations of waters (ppm) Analysts: BVFA Arsenal, BA f. Landwirtschaft, BA f. chem. pharm. baln. Unters.,Geol. BA, IGME, SCHNEIDER, et al.

By having Sulfate enriched and therefore metabolism accelerating (TOMPKINS, 1973) up to 40 °C warm groundwater (SCHNEIDER, 1973) or surface water, which is scarce and not fine for drinking one has to store rainwater in cisterns. Unfortunately because of the high air temperatures causing warm, nasty drinking water with serious risk of bacteriological incubation and additionally loss by evaporation they had to protect it by construction of cooling cap rocks. But as known under

arid conditions capillarity runs against gravity up and more to 7 m (KOLLMANN, 1984).

The same problem like the Mayas had the Egyptian too. To protect water reservoirs by using cap rocks could be done simply by constructing for example a pyramid, which provides the further advantage getting four triangle roof segments for better collection of wind drifted rain to catch infiltration at a circumference basal drainage system. The famous Greek historian HERODOT (in NUSSBAUMER, 1977) described the Great Pyramid in the second volume of his histories: "By using a subterranean channel water has been conducted into the pyramid; its inside being full with water and looked like a island surrounded by water". Preparing the foundation before building up the pyramids one has to ensure the horizontality of the four corners. Simple to level is possible by digging a trench (fortunately the Eocaen Nummulite-limestone is intensively faulted) and afterwards filling it up with water. The silty sedimentation of muddy water provides moreover a sealing bottom of the later reservoir, which might consists of thrown in gravels due to a porous aquifer. At two of the corners NAPOLEON's archaeologists found 1/2 m deep, appr. 5 m^3 large subterranean catchment-like basins (TOMPKINS, 1973). Besides one should mention that the time for preparing the foundation needed ca 10 years, i.e. 1/3 till finalization of the whole pyramid-building. The possible further function as a subterranean cistern for drinking-water supply, additionally to others, like a astronomical observatory, compass, calendar, watch, trigonometrical fixed point, terrestical measuring system, for dehydratation of mummies but also for cooling (storage of food) might be recognized better at the northern pyramid of El Lisht. Erosion by deflatation of the covering sandy soil seems to have buried out a wide-spread centripetal drainage system (Aerial photo in the Egyptian Museum in Cairo, seen 1997).

Directly beneath the top of several pyramides one can notice under the base of the foundation a central vertical shaft. These dampy-moisty holes with depth < 50 m havn' t been investigated sufficiently till now (HITCHING, 1979, 1982). They obviously look like a well! For infiltration down to this centric well the basal pediment has a slight inclination towards the first square stones, as can be seen by spill-tests. The vertical crease on the triangular -surfaces, which could be seen by different shadowing on aerial photos, especially at the Mykerinos pyramid, are thereby explainable. They had the function to conduct the infiltration path to the centre.

Drawing water out of the well by a goat-stomach using as a container it would be simple pulling it up to the outside by the slippery and upwards sloping passage (EDLINGER & KOLLMANN, 1998, 1999). From the entrance about 15 m above the ground they used probably the hydraulic self-pressure to supply the surrounding houses of Pharaos' clan (may be ... they enjoyed a wonderful view to the Nile valley?).

3. GeoHydrology - GeoMedicine

But drinking further on solely rainwater without essential minerals and trace elements like f.e. (alphabetical) Fluoride, Iodide, Lithium, Magnesium, Potassium, Selen, Strontium, Zinc etc (BRUNNER, 1996, MARKTL et al., 1996, PORTA, 1998) the sovereigns probably lost their self-confidence, domineering thirst for power and authority. Hence their influence upon the regular groundwater drinking subordinate people of Memphis (Tab. 1) decreased as can be seen in successive minor pyramids. Cheops' father, having built the step-pyramid in Sakara with an outside situated well in gypsum- and epsom-salt-sediments was formerly the increasing dominator in that dynasty.

Please apologize these audacious theory deriving from a self-medication with a surplus of 1 g/d Magnesium by the author, improving his neuromuscular behaviour. Austrian mineral waters, like the spa (salus per aquam) Bad Radkersburg named "Longlife" (nomen est omen?) or the "Purgina" are enriched with Mg (Tab. 1). But too much might cause severe renal failure by Hypermagnesemia, whereas a moderate (< 29 ppm Mg, for therapeutic application 67 - 134 ppm/day) consumption by drinking water improves statistically brain performance, concentration, stress tolerance and decreases blood pressure, probability of the occurrence of renal calculi, myocardial infarct risks, neuromuscular hyperexcitability, asthmatics, cerebrovascular and total mortality (MARIER, 1990).

Further on it is interesting that such salts were used as cathartic drugs during Renaissance times in Italy (BIRCH, 1990), as one might assume causing artistically abilities and faculties as known from sea coastal regions f.e. in the Netherlands (Rembrandt, Rubens etc) and the Toscana (Leonardo da Vinci, Michelangelo etc) would be imaginable by drinking that waters with more than 200 ppm Mg

(SCHULZ, 1978, WICKERT, 1997). Because of taking in Mg-salts by Italian priests it might be an interesting thesis to investigate the holy sites, like Assisi, Loreto, Lourdes, Mariazell (Dolomites and Magnesite of the Austrian Northern Limestone Alps), but also Canterbury, Glastonbury, Stonehenge, Tschenstochau, Salt Lake City (Mormones) or the river Ganges etc concerning possibly higher Magnesium contents of their local water. Maybe physiological together with psychological best feeling is the reason - and now coming back to Greece - that the colossus of Rhodos has been built by euphoria caused by to much intake from mineral water springs (Tab. 1, GIONI-STAVROPOULOU, 1983).

Due to the fact that Magnesium reacts as a anti-stress mineral (PORTA et al., 1997) by endocrinological quasi buffering of hormones like catecholamines (Norepinephrine, Cortisol, Endorphine) one might assume reversive effects vice versa. It seems that a surplus of Magnesium would possibly cause mobilization of these hormones too and that might cause the self-confidence-effect together with euphoria. This is .... an idea of a philosopher and hydrogeologist, studying now additionally human medicine.

4. Healthy waters in Greece

By that physiological-psyhological reactions deriving possibly from Magnesium and other essential minerals in a surplus overdose, there one might ask the question, whether further quasi superhuman performances or achievements in construction or art have caused some of the antique wonders of the world? Sites like Bodrum (water-sample from actual tap in Tab. 1), where the mausoleum of Halikarnassos was been built or the temple of Artemis in Ephesos, both in the surroundings of the locus typicus of Magnesium (there exists even 2 villages named Magnesia) seem to be causal connected.

Conspicuous at all are the facts of salt- and/or sulfate-fallout often to observe at foundatations of sacred buildings (i.e. Bycantine churches with drainage-trenches north of the Akropolis (GPS-Koord. 37° 59' N, 23° 44' E) and the coincidence of a lot of orthodoxe and christian chapels) further i.e. at the temple of Karnak und Edfu in Egypt together with Mg-containing groundwaters (Tab. 1: Luxor - Karnak "holy well and -lake"). Whether the origin of the 3 main world-religiones in the surroundings of the Dead Sea would be triggered by that Potassium- and Magnesiumsalt and the reason therefore perhaps would be adequat to more than sufficient physiological supply with minerals from local drinking water and the nutrition-chain seems to be verifyable by actual-hydrological methods. Hydrochemical datas from groundwater sampling results in the literature (AL-ALAWNEH, 1998, WATER AUTHORITY, 1987) and in-situ analysis (KOLLMANN, 1999) show values up to 304 ppm Mg in the Jordan-valley, culminating in maximum concentrations of 443 ppm Magnesium E. of Petra (Tab. 1).

Coming back to Greece, the evidence of Magnesium has been proofed by the studies of IGME presented in the map "Thermal-Mineral Springs in Greece" (GIONI-STAVROPOULOU, 1983) at sites like Nikrita, Rhodos, North of Athens, Area of Larissa (Magnesia), Loutraki, Korinthos where Ödopus lived and a lot of brothels (make love not war!) were established. Perhaps the former advanced cultures of Karanova (4.500 B.C.), enthusiastically described from M. GIMBUTAS (L.A., California, 1977 in: HITCHING, 1979, 1982) or Sitagroi near Kavala, where people were peace-loving, simultaneously rich, but also having all equal rights may be caused by good mineral supply from their local drinking water, ...quod erit demonstrandum by further interdisciplinaric geomedical-hydrogeologic investigations with hydrochemical analysis.

Actual (1998 and 1999) water sampling in Athens, resulting in moderate 30 ppm Magnesium, but 240 ppm high Potassium- (medication against cardio arhythmy and weak muscle tonus) concentrations, were done at the 28 m deep Metro construction trench (Makrigiani - Athanessiu - Diakou: GPS-Koord. 37° 58' N, 23° 44' E) just S. of the Akropolis (Tab. 1). Additionally it is proved at a well of the National garden, showing much more Mg, than in the tap (nowadays drinking water supply of Athens supplying with only 5,5 ppm Mg and 0,8 ppm K). Due to MARIER (1990), that difference of 5 times might be probably the reason of the modern hectic life in the city, because of generally deficiency symptomatic (no buffering of noradrenaline/norepinephrine surplus).

Among the 720 well known thermal springs in Greece, developed from ancient times, during the

Roman and Byzantine period of Greek history, up to now, the most famous are in spatown of Edipsos on the island of Eboea (GARAGUNIS, et al., 1997). Two groups of high mineralized (4 - 8 g TDS/l) of most productive (5 l/s + unknown amount mixing with sea water at the coast) thermal springs (50 - 60 ^{o} C and 70 - 84 ^{o} C) are sedimentating sinter by loosing CO_2. The source rocks are volcanic Andesite (Magnesiumsilicate from Tertiary age?), permeable limestone and Magnesite, surrounded and covered by impermeable Bauxite, other neogene minerals and schists.

Healthy and sane are these waters not only by their temperature and valuable traces of Radon gas but most important because of the high Mg contents up to 338 ppm and also K < 503 ppm (Tab. 1). A little bit lower concentrated are the waters of Kamena Vourla (Asproneri spring), but therefore preferable good for drinking (Tab. 1 "C" is mentioned as similar to Evian: 33 ppm Mg).

A further effect of good physiological status - probably caused by the nutrition-chain - has mentioned from BITSCHNAU, M. (1997) by evaluating some epidemiological investigations on the island Cyprus, the birthplace of Aphrodite, the goddess of beauty. It is a fact ocurring there less cancer than in other countries of Europe. Cyprus people are mostly vegetarians eating bread, fruits, vegetables and are using much of normally pressed oil of olives further prefering halogenide enriched marine fishes and regular moderately red wine (WORM, N., 1996). Considering that nutrition-chain a Geologist tries to back coupling the geogene resources and by looking on the geological map of Cyprus (BEAR, L. M., 1963) one can recognize the island consists of mainly alkaline - ultraalkaline Magnesiumsilicate rocks like Olivine- and Pyroxenegabbro, Ophiolites, Peridotites, Epidotdiabase and Serpentinites, further Vulcanites (Andesite, Dazite, Basalt), Carbonates i.g. with a lot of Magnesite-minings, miocene gypsum and last not least detritus clasticas of them all in Plio-Pleistocene (KOLLMANN, W., 1998).

By fertilizing Cupressocyparis trees for their therapy with Epsomsalt $MgSO_4$ (for producing chlorophyllum plants need Mg which builds the central atom and that is necessary for the Photosynthesis) the GeoMedical interested author won the first knowledges in Mg-research (EDLINGER, E. & KOLLMANN, W., 1997, 1998).

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Diets SAUER

Geology and Health

Men was adjusted to the environment for more than 2 million years. A great number of chemical elements is necessary to build up human enzymes and hormones and most of these elements are the central atomium of them. Not all of them are known to us and until recently we did not even know their function. The same is true for the metabolism of animals and plants. Elements that ended up in the human food chain are those that were found to have a well-balanced equilibrium in the geological environment. In areas where this equilibrium is disturbed no life could evolve. The presence or absence of certain chemical elements determined health or illness. Recently trade and mobility made it possible for humans to settle in regions where the supply of necessary chemical elements from the soil is not sufficient. We now know, for instance, that elements such as boron, copper, molybdenum, zinc or manganese can increase the productivity of the soil for cereals and vegetables. By contrast the presence of zinc, copper, iron or cobald significant reduces the absorption by the plant of essential elements such as nickel or titanium. Equaly, the lack of manganese, boron, copper, molybdenum, selen or cobald leads to the death of plants and animals. Probably the same is true for humans. It turned out that elements that appeared to be toxical to men are rearly essentiel for human life. However, in most of the natural deposits the proportion of chemical elements is well balanced with the effect that each toxical element has ist counterpart in a nontoxical one. In the future it will be necessary to pay greater attention to the proportions of chemical elements in our environment. It will then become possible to better understand and influence the effect of those chemical elements on the human metabolism.

The Geology of Health

Again and again the question is asked as to what could have caused the extinction of species. Today we know quite a few of the catastrophies that led to extinction of 98% existing of the time like to Xixolub impact for instance. Others, such as the extinction of the Neanderthaliensis still remain a mystery. Generally speaking it can be maintained that a particular species dies out when it is no longer adjusted to its environment. This can happen through disease just as much as through catastrophies, through change in the climate or a shortage of food.

Even when there is plenty of food available essential trace elements may either be missing altogether or may occur in toxic concentration.

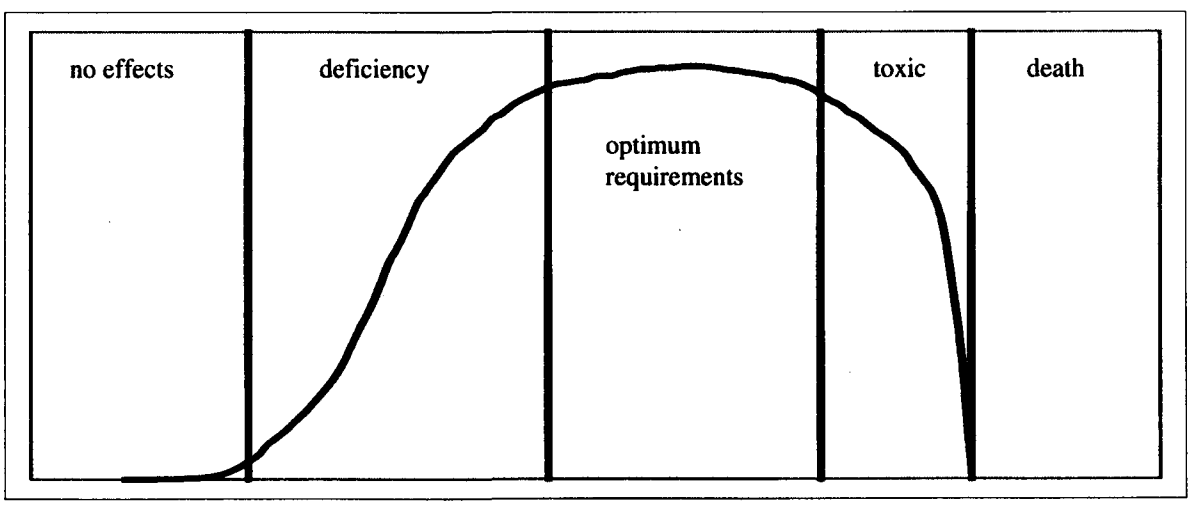

Fig.1: Physiological effects

Man - like any other form of life - has adjusted through millions of years to chemical trace elements supplied by the soil. If the supply of certain trace elements is too large the result is poisoning if it is insufficient deficiency diseases occur. The existence or lack of a particular trace element depends on the geochemical environment. Life - to no small degree - is influenced by what soil does or does not supply.

Hundred and more years ago one could be reasonably confident that the supply of chemical trace elements was just right in most populated areas. If it was not right no lasting cultures could develop.

However, colonisation and trade have changed that as it became possible to settle in areas – at least temporarily - that were less favourable to man; it also became possible, due to technology, to mine and distribute all over the globe those chemical elements that in nature mainly occur highly concentrated in deposits and that enter the circulation of elements in small quantities only.

In most populated areas the chemical elements man has adjusted to and which h absorbed from the soil in the food chain existed in a well balanced equilibrium. Since industrialisation a continuous distribution of chemical trace elements resulted in a grass imbalance which finds its expression in human health or the lack of it.

The use of chemical fertilizer was a weak attempt to minimise the damage. It should be noted, however, that it is not possible to reproduce the natural balance of the chemical elements by this method. Above all the soil develops a shortage of essential trace elements such as selenium, zinc, copper, manganese and others.

Chemical fertilization rarely is used in order to improve the health of mankind, it rather is done with the aim of increasing the productivity of the soil and thus profit.

boron for	sugar beets, rape and potatoes,
copper for	wheat and barley,
molybdenum for	vegetables rape and sugar beet,
zinc for	corn and sugar beet,
manganese for	grains and rape.

Tab. 1: Trace elements for chemicl fertilization

Indeed, the possibillty of increasing the growth of wheat with the help of copper has already been known to our forefathers.

Dr. Thalman of VOEST has been told the secret by an old farmer. He used to coat his plowshare with copperplate with the aim of increasing his profits. At may rate it has become clear that the transport of trace elements and their availabillty in the soil in plants and in animals ultimately depends on various metabolisms. It is the composition of a solution in the soil that determines the threshold of trace elements for their absorption by plants; this is so because roots can absorb those solutions only when certain trace elements act as catalysator.

The concentration an the kind of chemical trace elements existing in a particular soil are determined on the one hand by the geochemical milieu and by biological factors on the other micro-organism in the soil are active directly and indirectly. Indirectly, by producing exocellular metabolites, by synthesising high molecular humus matter and by the pH and E_h values.

Trace element	Disturbing element	reduction of intake in %
Cd^{2+}	Zn^{2+}	25
	Cu^{2+}	33
	Fe^{2+}	17
	Mn^{2+}	25
Tl^{+}	K^{+}	57
Ni^{2+}	Cu^{2+}	42
	Zn^{2+}	30
	Fe^{2+}	33
	Co^{2+}	25

Tab. 2: Influence of other elements

Out of 239 metal-insensitive bacteria 165 produced metabolites, which complexes nickel. All 59 fungi isolated from the soil behaved in this way. A great number of them stabilised Ni against hydrolysis and increased solubility by a factor of 1000 compared to inorganic nickel.

However, not all disasters are man made. Even in the nature trace elements do not always occur in an ideal balance. Even in natural soll different chemical elements can either be in short supply or they can exist in excessive amounts. Today we can relate the occurrence of certain diseases of plants and animals to the existence of certain trace elements in the soil. Already we know a great number of chemical trace elements whose shortage courses symptoms and deficiency diseases in plants, animals and man.

Element	Symptom	Deficiency disease
Mn	younger leaves brown stained	dry spot disease at Grains, Intercostal-chlorose at beets, lickmania at ruminants
B	shoot dying out, latest leaves withering	Heart - and dry rot at beets, brown-spot at cauliflower, fade of blossoms at fruit-trees
Cu	Leaves dirty, deaf ears. at more than 4 ppm molybdenum in the soil: deathbom ships, total	heart failure at cattle, moorland disease at grains, treetop dryness at fruit trees, hypocuprosis
Mo	grey leaves	disease at cauliflower
Se	necrosis at the liver, myocarditis at calves and lambs	white disease
Co	Declining wool production at sheep	bush sickness at cattle

Tab. 3: Element correlated deficiency diseases

A well known deficiency disease is the goitre caused by a shortage of iodine for instance In China the Ke-shan-Krankheit occurred in the following provinces: HE LONG JIANG, JI LIN, LIAO NING, NEI MON GOL, HE BEI, SHAN DONG, SHANXI, HE NAN, SHAANXI, GANSU, SECHEN, YUNAN, XIZANG, HU BEI and GIU ZHOU. Millions of people there died of a heart disease caused by an extreme shortage of selenium in the soil. Oral selenium substitution saved the lives and health of millions of people. In Finland, where the soil in equally is deficied in selenium, chemical fertilization was used in an attempt to add selenium to the soil.

Further imbalances of selenium in the soil are responded of the North American prairie-regions between the Golf of Mexico to Saskatschewen, of South Africa, Ireland, Israel and North Australia.

But a shortage of other essential trace elements such as zinc for instance also causes diseases. Soils deficient in zinc was found in North - Dakota, Nebraska and in the plains of Colorado. A series of several investigations was conducted in Austria as the consequence of a scandal in Arnoldstein where the pollution of the atmosphere with heavy metals was found to be particular high. One of the results was the finding that zinc and lead are genuine antagonists.

Location	Lead (ppm)	Zinc (ppm)
Arnoldstein	6,8	81
Carinthia	1,08	152
Waldviertel	10,90	151

Tab. 4: Pb and Zn conentrations in Austrian aeras

A similar result was attained with hair analysis of workers at a roasting plant in "Yuzhutalsoboto-Combinat, Plast, South - Ural the independent variable was duration of employment (in ppm). It was observed that - with time – the concentration of heavy metal increased whereas that of zinc and selenium decreased. A possible consequence of this could be suppression of defence mechanisms in the human body.

Element	1 - 5 years	6 - 10 years	over 10 years
Al	13,38	11,44	14,41
As	135	185	233
B	4,52	4,88	7,41
Bi	2,42	1,66	1,58
Ca	2968	2958	2962
Cd	0,82	1,22	1,29
Co	1,09	1,07	1,08
Sb	7,02	9,55	11,28
Cu	15,29	19,72	18,71
Fe	49,34	150,84	74,20
K	161	137	208
Li	0,12	0,13	0,10
Mg	461	420	466
Mn	3,05	3,03	4,59
Mo	0,67	0,69	0,69
Ni	2,01	0,26	1,26
P	303	255	294
Pb	4,85	8,46	10,82
Hg	0,20	0,51	0,37
Se	10,36	8,55	6,91
Ti	2,05	1,56	1,68
Zn	1366	1336	300

Tab. 5: Concentratopn of trace – elements in hairs of workers

This is where the interference of men in nature can be observed particularly well: In natural deposits, lead, cadmium and zinc never occur one without the other, so that man absorbs with the his food a well balanced ratio of noxious elements together with antagonists. Thus men's health is not endangered. It is only when these trace elements are separated from their antagonists through industrial processes that they becomes toxic. Chromium is officially known to be a toxic element. It is only recently that is was discovered in animal experiments that chromium is also essential for the living organism. Again in animal experiments chromium deficiency caused diabetes. In man a shortage of chromium causes arteriosclerosis, growth disorder and the clouding of the lens in the eye. In short, man cannot live without chromium. Usually the concentration of chromium is as follows:

10 - 90 mg/kg in the soil, 0,0003 mg/l in sea water and 0,01 mg/l in fresh water. The concentration of chromium in a non-industrialised atmosphere is around 10 $\mu g/m^3$. These values are very often exceeded nowadays as the following figure shows : In rivers and streams values up to 10 mg/l were observed. Values as high as 25 mg/l were found in drinking water. The atmosphere of industrial towns contained up to 70 $\mu g/m^3$ chromium and the exhaust fumes of coal firing ovens up to 2 mg/m^3. Plants have a concentration of 0,02 - 14 mg/kg dry weight chromium.

However, for the diet of animals and man the valence of chromium is important. Biologically active chromium is found in the non-refined syrup made of sugar cane and sugar beetroot, in wheat germ, in black pepper and in brewers yeast. Those substances are thus helpful for avoiding symptoms and deficiency diseases. Fruit are known to contain very little chromium. In food derived from animals chromium is biologically available to different degrees. The highest concentration of biologically active chromium was found in liver and in cheese. In the adult human body the chromium content around 600 µg. Higher concentrations were found in human hair, in the liver and an the spleen. The German society for Nutrition has estimated the following daily needs of chromium for:

babies up 6 month	10-40 µg
infants up to 14 month	20-60 µg
Children between age of 1-3	20-8 µg
Children between age of 3-6	30-120 µg

Tab. 6: Faily neds of chromium for children

The question at which concentration on the soil chromium begins to be harmful must be seen in the contact of its biological avallability. It is well known that fertilisation with calcium hydroxide and phosphate reduces the plants sensitivity to chromium. In man the simultaneous administration of phosphate, calcium and iron does not make sense due to the action of their antagonists. Only very low

concentrations of chromium were found in the edible parts of plants in solis that have been heavily fertilised with chromium. Spinach had the highest concentration of chromium, up to 23 mg/kg dry weight. In other plants substantially lower chromic concentrations were observed under identical conditions. The maximum concentration of 0,5 mg/kg was found in the grain of winter-rye.

Chromium in the form of glucose-tolerance-factor (GTF) is easily absorbed from the diet, as such it is also able to overcome the placenta barriere. In a biological milieu chromium (VI) is reduced to chromium (III) with possible damages due to oxidation. By contrast, chromium (VI) can penetrate biological membranes with ease thus reaching the inside of the cell. Chromium (III) cannot do such things and it is therefore very little toxic. Recently, suspicious could be confirmed that chromium once it has penetrated the cell as chromium (III) can turn mutagenic and thus carcinogenic. So, the relative harmlessness of chromium 8III) could be explained with its inability to penetrate biological membranes.

In 1957 SCHWARZ and MERTZ discovered so-called glucose-tolerance-factor (GTF) a substance that is next to insulin - important for the glucose metabolism. Later they found that the active part of GTF was non other than chromium (III), but the exact structure of GTF still remains to be discovered. Next to its role for the metabolism of glucose chromium also seems to play a part in the metabolism of fat. It appears to delay the onset and development of arteriosclerosis. In 1978 NEWMAN at al. Found a significant correlation between a low level of chromium in the blood serum of arteriosclerosis of the coronary vessels of man. According to findings brewer's yeast - rich in GTF - increases the level of HDL cholesterol and decreases that of LDL cholesterol in men, both reactions that are believed to reduce the risk of arteriosclerosis.

The company Biopan commissioned a study to investigate the effect of regularly administrated chromium an the metabolism of carbohydrate. Patients suffering from diabetes mellitus type II and hypocholesterinanemia were given 200 micrograms of chromium (GTF) before lunch during 6 weeks. The data was analysed by 7 Austrian physicians . Blood sugar level were measured at the beginning of the study and 2 and 6 weeks afterwards. On average, a reduction of blood sugar level first to 84,1 % and later to 76,2 % of the original level was observed. To summarise those findings: it seems helpful to prescribe chromium (GTF) to patients suffering from diabetes type II and high level of cholesterol but low HDL level. A low-calorie-diet, usually recommended for such patients, further reduces the chance of taking in sufficient chromium. As the study has shown this constitutes an additional risk-factors.

Refined sugar is especially bad because the naturally high concentration of chromium / GTF of sugar beetroot and sugar cane is lost. Chromium as a compared of GTF is a trace element that improves the effect of insulin so that it becomes possible to regulate blood sugar levels. Less clear is the effect of chromium on the metabolism of fat; but as the study has shown chromium also has a function here which justifies its cautions use. It is interesting to note that the plants with the highest concentration of chromium are also that are the basis for the production of sugar namely sugar beetroot and sugar cane. Both would contain sufficient chromium to produce GTF insufficient quantity to counteract the essentially harmful effect of sugar. However, by refining, non extracts with great success the artificial nature has provided. Tellurium is a rare element on earth. It takes 75th place among the other elements and belays to group VI in the periodic system together with oxygen, sulphur and selenium, all elements of biological interest. Oxygen is a component of water as well as protein and sulphur is essential for proteins. But we only learned recently that selenium is the central atomium of glutathionperoxidase, an enzyme that protects the organism from harmful radicals by getting rid of the waste products of oxidation. It is also believed to slow down ageing and to present coronary heart disease. A shortage of selenium causes cancer at a significant higher rate.

With the analytical methods of the late 60s it was not possible to detect tellurium either in sea water or in the soil, but it could be found in ash of coal. It was hypothesised that plants take up this element and that is accumulates during coal formation.

organ	µg/g	total in the organ mg
muscle	0,63	18,90
intestinal region	0,50	1,00
brain	1,88	2,82
liver	4,36	7,41
lung	0,99	0,99
kidney	0,88	0,26
heart	0,83	0,25
bones	77	539
fat	1,8	18

Tab. 7: Tellurium in human samples

So it is astonishing to find tellurium levels as high as 1035 ppm in the ash of human liver using neutron activation analysis. Lower, but still remarkably high levels of tellurium were detected in bone and kidneys and lung tissues as well as in the ovaries and testicles of men. It seems not farest to ask: could it be that tellurium is as essential a trace element for men as is selenium?

To find an answer to this question investigations with samples of human organs as well as with food samples were carried out at the institute of physiology in New Hampshire. The largest concentration of 9 % was detected in bone tissues followed by muscles and fat with 3 % and liver with 1,2 %. It was aestimated that the human body contains around 600 mg of tellurium. If this turns out to be correct tellurium would be one of the most frequent trace element in the human body together with iron, zinc and rubidium. It would be twice as frequent as zirconium, four times as frequent as strontium and six times as frequent as copper whereas manganese only for a thirteenth and chromium of a hundredth of this value.

Wet ashed plant	µg/g
Red onion	12,96
White onion I	5,50
White onion II	14,31
Little onions	1,75
Little onions, superphosphat fertilised	5,45
Garlic I	72,86
Garlic II	71,30
Garlic III	30,97

Tab. 8: Te contents in vegetables

As things stand, tellurium seems to be a highly important trace element for men. Indeed, quite remarkable quantities of tellurium have been found in the human food chain: Tellurium was found in human muscle tissues but not in the muscles of animals, nor in the most sea food. We do not know yet by what mechanism tellurium is absorbed by plants. Relatively high levels of tellurium were found in leek plants:

For a long time the healthy compound of garlic has been believed to be its high content of selenium. New studies, however, have led us to believe that rather than selenium it is the tellurium compound of garlic which is responsible for the biological positive effect even though we can not explain it yet. However that may be, several studies have shown that tellurium blocks the emphasis of cholesterol.

In studies of the university of Bar-Ilan, Ramad Gab, Israel, ammoniumtrichloro tellurates, called ACE 10, showed an immunostimulating effect. Thus same substance has an anti-tumour effect in rats without any toxic side effect. In addition it caused an increase of human lymphocytes and of T 4 cells in vitro. Running studies with AIDS- and cancer patients who were injected with 2, 3 and 5 mg/m³ of the above mentioned tellurates 3 times a week did not show any side effects, but an increase of CD4 cells was observed as well as an improvement in the CD4/CD ratio. Patients furthermore felt significantly better.

Currently the US food administrations investigating the modulating effect of this tellurium compound on the immune system as possible drug against AIDS.

Anyhow, one thing has become clear: further investigations will be necessary to fully explain the effect of tellurium and its deviates but already the success with cancer and AIDS therapies is

encouraging. In folk-medicine garlic - rich in selenium and tellurium has long been used preventionely as well as a remedy against certain illness just as garlic has been used as a staple food in different cultures. This leads us to conclude that men must have adjusted to tellurium through evolution.

Very often though it is not so much the low level of a particular trace element that is detrimental to health but rather the simultaneous low level of several trace elements at one time. In the future therefore we should pay more attention to the balance of certain elements such as Cu/Mo, Zn/Co or Zn/Cu.

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Joseph SAMAN

The Properties of the Curative Water and its uses for Therapeutical Treatment in Jordan

Abstract

The paper discusses some of the natural agents in Jordan with particular emphasis on thermal mineral water.

Despite the scarcity of water resources in this Semi-Arid Country ,Jordan enjoys the abundant presence of sources of thermal and mineral waters distributed all over its territories along the Rift Valley. The eastern flank of the valley comprises some 150 thermal water springs and many wells ranging in temperature from 300- over 600 °C.

The thermal springs were used in ancient time for therapeutical purposes. The conclusion, that these thermal waters are curative, is based actually on their chemical and physical characteristics as well as medical indications and field experiments. Generally stated, the thermal waters of Jordan are very promising. Jordan is moreover famous for its touristic and archeological sites which enable it to be a therapeutical center allowing millions of tourists to investigate its different archeological sites and enjoy treatment in its spas and thermal springs.

This requires of coarse the developing of its therapeutical sites in different aspects, unless the present status of most of the sites will not fulfill international requirements, unless improvement and better advertisement are implemented.

Further research is of the utmost importance in order to optimize the use of the thermal waters, which could be a main support for the economy of the country.

Introduction

Jordan lies within a semi-arid to warm mediterranean climate. It is a country with scarce Water Resources, but enjoys the abundant presence of Thermal and Mineral Waters distributed all over its territories and especially along the Rift Valley to the South of Sea Genezareth towards the southern part of the Dead Sea.

The Dead Sea is rich in Minerals, which have proved its effectivness in the treatment of skin diseases, especially psoriasis.

The thermal water springs, with their physical and chemical properties are widely spread in all the kingdom areas. In the north we find mineral waters in Himma area and north Shunah.

This is in addition to the middle areas, particularly Azraq Oasis and main spas and the Zara area overviewing the Dead Sea. In Tafila south of Jordan we have the Afra and Barbeeta thermal springs.

These springs are highly effective for the treatment of various diseases, in particular Skin and rheumatic diseases. This makes of the medical treatment waters in Jordan one of the most important pillars of curative tourism in Jordan.

The sites of curative waters enjoy also special climatic conditions with long dry summers and cool

wet winters with air oxygen concentration increasing, with decreasing elevation towards the Dead Sea.

Jordan is qualified to be therapeutic center due to its touristic and atmospheric attraction. However it is enowed by an abundance of archeological sites.

Millions of people can be attracted to seeing and enjoying the treatment of its curative spas.

In earlier times, as can be seen from the remaining ruins surrounding the thermal springs and as reported in historical romans and Nebatean eras, where thermal waters were used widely for therapeutic purposes.

The descendants of the old Nebatean, the bedouines as the native Inhabitants of this area used these waters for the treatment of these ailments.

Jordan hot springs have certainkly attracted visitors at least 2.000 Years, ever since Herod the Great took the cure at Zarqa Main, now the Site of the middle east most modern mineral water health-spa. These waters were also highlyappreciated as a healing curative tool (Heilende Kraft). In some cases where modern medicine was unable to help, the thermal waters were of overwhelminmg success.

It requires of course the improvement and development of its therapeutic sites according the Intenational norms. Since the present stand of most of sites do not fulfil the requirments for Intenational competion such as services, standard advertisement and proper marketing.

Special emphasis should be stressed on further Investigstion and research of the properties of the curative waters, which has an economical importance and very valuable resource.

Definition and characteristics of curative water:

According to the classification of the International Society of Medical Hydrology, the Societe International de Technique Hydrothermale (SITH), The International Association of Spas, Health Resorts and Balneology and the German Health Resorts Association, Deutscher Badeverband, a water source can be classified as curative if possees one or more of the Following Properties;

1. 20 mg/l Fe, (iron mineral water)
2. 1 mg/l I, (iodide mineral water)
3. 1 mg/l H_2S, (hydrogensulphide water)
4. 18 nCi/l (nano-Curie) radon, (radon water)
5. 1000 mg/l CO_2, (carbon dioxide water-acidic water)
6. 1 mg/l fluoride, (flouride rich mineral water)
7. In Jordan water is considered thermal if its teperature exceeds 27°C

The therapeutic characteristics of the water

The therapeutic characteristics are categorized according to:

- The type of positive or negsative ions present which exceed 20% of the total positive and negativ ions in the water.
- The presence of an active substance such as iron, sulfur, fluoride or radon.
- The water temperature.
- In order to assign therapeutic properties to a water source, it is necessary to define its chemical and physical properties and to classify them according to the international norms.
- Topography, setting of the area, climate and environment are also of importance for the curative water.

15 thermal springs out of 200 have been subjected tointensive studies in order to identify their phsical, hydrological, geological and chemical characteristics thermal spring location.

After Salameh E., five medical experiments have been conducted on patients suffering from various rheumatoid diseases in the following areas:

1. Afra thermal spring
2. Main thermal spas
3. Azraq thermal well
4. North Shuna thermal well
5. Himma of Jordan

Source and origin of minerals, gases and physical properties: The chemical constituents of the thermal waters are derived from the percolated rocks. Some of these rocks posses unique properties.

1. Metamorphosed oil shales in north Jordan along the slopes of the Yarmouk river and in the Qatraneh and Dabba areas, 40-60km SSE of Amman.
2. Phosphatic rocks containing trace elements in abundance (U, Zn, Mo, Ba, V, etc.) and covering large areas of Jordan, i.e.Russeifga some 10 km E of Amman, Hasa 130 km S of Amman, Shadiya 240 km SSE of Amman.
3. Sandstone of lower cretaceous and other ages containing heavy sand trace metsals like Fe, Mn, Pb, Zn, U, Ni, Co, etc.
   These areas and types of rocks are percolated by the waters of the thermal springs.

Normal gases

- Oxidation processes can explain the high concentration of carbon dioxide and hydrogen sulfide gases, where the dissolved oxygen in the water reacts with the organic matter in the rocks or in the water itself. The water contents of heavy and trace elements such as Fe, Mn, Cd and Zn etc. are attributed to dissolution processes of rocks and minerals percolates
- Salts: Some springs have high salt contents, which are attributed to mixing of infiltrating water with old salty water in the aquifers or with the Dead Sea water along the interface of fresh/salt water.

Radioactive substances

When the infiltrating water passes through phosphatic and granitic rocks, or through oilshales or old sandstone, it dissolves parts of the Uranium minerls present in these rock types.

Radon: is one-othe unstable (radioactive) elements in the Uranium 238 disintigration series, which constitutes 99% of the Uranium isotopes.

U 235 and Th.232 disintigrate also and give other isotopes of radon with very short half life time (radon 219 ca.4 seconds, radon 220 ca.55 seconds whereas radon has a half life time of 3.82 days.

Radon is characterized by its presence as a gas under normal pressure and teperature conditions. It dissolves in wate as a gas and escapes as soon as it is in contact ewiththe atmospherethe radon gas disintigrate to another radioactive substance, namely polonium in a solid state and which in turn disintigrate within the uranium series to lead 206. The half-life time from radon 222 to lead 206 lasts around 21 years.

In the following are the two-disintegration series (thorium-232 And uranium-238), which produce radonat two different stages.

Curative waters and springs in Jordan

There are numerous springs sand water seeps in Jordan. These are grouped into two tyhpes according to source and teperature.

Fresh springs (hypothermal)

With temperature 20-30°C.These are of less importance, they issue from the carbonate rocks (Upper Cretac.) in age. Two important springs of this group are worth mentioning.

Ain Ez-Zarqa

It issues from the cenomanian limestones in the upper part of Wadi Zarqa-Main.The total discharge is about 80 m^3/h.

Uyun Musa

These springs issue from the bottom of the turonian limestone (A7). Temperature of the springs ranges from 18-21°C. They reach their maximum discharge in march (95 m^3/h) and decrease to58 m^3/h towards the end of july.

Thermal springs

They are concentrated along the easter Jordan rift valley, from south to north Tafila area, (Wadi El-Hasa, Wadi Afra)

- Wadi Afra Springs

The hot springs are concentrated near the confluence of Wadi Afra and Wadi El-Hasa. The total discharge is about 450 l/s. The water emerges from the Kurnub Sandstone (Aptian /Albian), it is overlain by limestone, dolomites and marls of upper cretaceous. The temperature of the discharged water is almost constant and ranges from 47-49 °C, indicating that minor or no mixing with surface water take place. The chemical composition shows that the water is of alkaline earth type with increased portion of alkalies and prevailing chloride. The water is radioactive with an activity equal to 7.2 nCi/l. The curative properties of this water are based on the elevated temperature, CO_2-content. bromide and radioactivity could be of medical value.

Medical Indications:
Restoration of general activity, arthritis, chronic arthritis peripheral circulation troubles,muscular contractions, muscle cramp, regulation of gland secretions, gynecological diseases, general health recovery, infertility, pain soothing, nervous prostration, rheumatism

- Wadi El-Hasa thermal Spring (Burbetah)

It issues from the bed gravel of Wadi El-Hasa .Its water originates from the lower cretaceous sandstone underlying the gravel. The thermal water seeps to the surface at different places from the aquifer. In comparison to Wadi Afra, the water temperature here shows seasonal changes. It rises in summer to 46 °C and drops in winter to 24 °C.This change in temperature is accompanied by changes in the chemical composition indicating the mixed nature of the water .The radioactivity of the water ranges from 2 to 7 nCi/l. The high radioactivity due to radon 222 in both Afra and El-Hasa springs could be attributed either to the leaching of the uranium rich phosphatic rocks or the dissolution of uranium oxides within the sandstone units or both. The presence of thick marl, sand, marly limestone beds separating the phosphatic rocks from the spring sites supports the probability that the radioactivity originates from the sandstone. The curative properties of this water are based on its high temperature and radioactivity. The Fe (iron) content could be of medicinal value. These properties are equivalent to those of Afra.

Lisan area (Ghor El-Karak, Wadi Dhira, and Wadi Ibn Hammad)

- Lisan Thermal Springs

The thermal waters in this area are discharged to the Lisan and from there to the Dead Sea.

- Wadi El-Dhira Spring

Many springs issue in the lower portion of Wadi Dhira along fault planes trending NNE-SSW parallel to the main flexure trend in Ghor El-Safi area. The Main spring discharges as a bubbling spring from lower cretaceous sandstones at an elevation of 100m,a.s.l. The amount of water discharged is about 30 l/s. with a constant temperature of 33 °C.

Medical Indications:

Peripheral circulation, troubles, chronic constipation, muscle contractions, diuretic, general health recovery, rheumatism, urinary lithaiasis, sandstone underlying the gravel

Zarqa Main and Zara area (Wadi Zerka-Main)

- Zara and Zarka Main Thermal Springs

The Zara thermal spring area lies 1 to 4 km to the south west of Zarqa main area and some 100 – 1000 m to the east of the Dead Sea shore. The thermal spring discharges from the upper part of the sandstone aquifer low. cretaceous) in age, partly covered with recent sediments of travertine and gravel. The water normally issues along N-S trending faults. The temperature of the different springs is constant over the year and goes up to 63 °C the chemical composition is very similar to those of Zarqa Main, which proves that both springs are of the same Origin.In summer the water is alkaline earth with prevailing alkalis and increased portion of chlorides. It includes together 26 thermal springs within the Zara area.The estimated total discharge into the Dead Sea is about 17MCM/a; including the fresh water of some springs in the area H_2S is discharged with the water, and gives the area its distinctive smell. The water is radioactive with up to 3.7 nCi/l and a bromide concentration of about 5 mg/l.

Jerash - Deir Alla area (Zerka River)

Two thermal springs issue along the Zerqa River course.

- Himmat Jarash

This spring issues at an elevation of 220 m a.s.l. from consolidated Wadi gravel about 2 km east of the new Jerash bridge on the road from Amman to Jerasah.. The underlying sediments consist of lower cretaceous sandstones. The temperature ranges from 27 °C in summer to 29 °C in winter. It indicates alkaline water with prevailing chlorides in summer and alkaline earth water with prevailing alkalis and increased portion of chloride in winter. The water can be used both internally and externally.

- Deir Alla Spring

This spring issue from Wadi gravel covering the Zerka River bed in the area where the Zerka river leaves to the Jordan graben. The water temperature ranges from 35 °C in summer to 38 °C in winter indicating the mixed nature of the water. The source of water is not clear but it seems to have its origin in the jurassic and cretaceous rocks. The great changes in the chemical composition varies (e.g. Cl 44 mg/l in summer and 1720 mg/l in winter) showing the high mixing ratio changs during the seasons of the year. The water is alkaline with prevailing chlorides in winter and alkaline earth with prevailing bicarbonates in summer. Iron oxides precipitate as soon as the spring water mixes with the Zerka river water. CO_2 gas is discharged with the water.

Therapeutic uses:

Ankylosis, arthritis, and central circulation troubles. Peripheral circulation troubles, chronic constipation, muscle cramp, general health recovery, Influenza, respiratory system troubles rheumatism, urinary lithaiasis urethritis

- Himma and Wadi El Arab thermal Springs

Three Wadis are herein included: Yarmouk River; Alhimma Spring

Himma of Jordan, Mukheiba and North Shuna

- Wadi El Arab, North Shuna well, Wadi (Hammam Abu Thableh) Spring

- Himma Springs

The thermal springs are concentrated along the lower reaches of the Yarmouk river. They emerge from the chalk marl unit at an elevation of 115 m below sea level. The changes in chemical composition over the seasons indicate the mixed nature of the water. In summer the water is alkaline earth with prevailing carbonates and chlorides, whereas in winter it changes to alkaline earth with prevailing bicarbonates and increased amount of chloride. This water can be used both internally and externally with some restrictions to its use internally.

Therapeutic uses:

Arthritis, peripheral circulation troubles, muscle cramp, regulation of gland secretion, activation of ducts of sweat glands ,general health recovery, inflammation of respiratory apparatus, rheumatism

- Wadi El-Arab (North Shuna Well)

This well was drilled 1981 to a depth 1000 m. At depth 970 m, the water became flowing to a height of 17 m. The discharge was 250 l/s with a constant discharge .The temperature was measured to be 56 °C. The aquifer is the so-called upper Ajloun (A7), massive limestone, turonian age. Great amount of H_2S gas is also discharged with the water, the concentration reaches 12 mg/l the chemical composition and the temperature. Gave the expected curative properties as the Himma Spring.

Therapeutic uses

Restoration of general activity, arthritis, muscle cramp, activation of ducts of sweat glands, general health recovery, pain soothing, rheumatism

- Hammam Abu Thableh Thermal Spring

This spring lies a few kilometers to the north of the historic city of Pella in the Jordan Valley Area. The spring surroundings are covered with travertine and other recent sediments, which are underlain by limestone of upper cretaceous age; the chemical composition indicates a mixture of two water types. In summer the is alkaline earth with prevailing carbonates and chloride and in Winter it is alkaline earth with prevailing carbonates and increased portion of chlorides. Little H_2S gas is discharged with the spring water. The water is radioactive with 4.9 nCi/l of Rn 222 activity. The H_2S content is high.

Therapeutic uses

Arthritis, peripheral circulation troubles, muscles cramp, regulation of gland secretions, activation of ducts of sweat glands, rheumatism.

Azraq thermal water well

This Well was accidentally encountered during drilling for oil exploration. This artesian well reached a total depth of 1299 m before the water became flowing from the lower cretaceous sandstones to the surface. The discharge water is constant, 39 °C, and the reservoir temp. Are 72 °C. H_2S gas is discharged with the water. The CO_2 concentration is 210 mg/l and the radioactivities 2.5 nCi/l. The water can be used both internally and externally. Due to its H_2S content it is recommended for moderate use internally.

Therapeutic uses
Arthritis, muscle cramp, inflammation of respiratory apparatus, rheumatism, skin diseases.

In northeast Jordan

Some 100 km east of Amman; an artesian well known as Azraq Well penetrates to a depth of 1299 m and produces thermal water with temperature of 56 °C.

Jordan Ghor Springs

The prevailing climate in this area is a desertic one with hot summer, with an average temperature of 31 °C. The hunidity annual average is around 15 % and rainfall reaches 100mm/a., increasing towards north up to 300 mm/a. in North Shuna and 400 mm/a. in the jordan Himmah area.

Mineral water in Jordan southern Ghore area

Hisban Spring

Two wells have been drilled in Wadi Hisban area. The water however found its way to the surface through fissures within the overlaying rock formation.The chemical and physical properties of this water do not change throuhout the year.This water is considered thermal –mineral water, of sodium – calcium, chloride –bicarbonate type.The concentration of dissolved salts reaches 3 mg/l; the radon concentration in the water reaches 23,58 nCi/l with an average of 15,5 nCi/l.

Wadi Kafrein Wells

Three Artesian Wells in this area were drilled .The temperature varies between 32,5 – 37 °C. The physical and chemical properties are fairly stable. Although the concentration of dissolved solids does not reach 1000 mg/l, yet this water is considered thermal water of calcium-sodium-magnesium-bicarbonate-chloride type. The concentration of radon, carbon dioxide and hydrogen sulphide and hydrogen sulphide is minimal.The water could be used for therapy through drinking. Due to the relatively high Iron content, it is especially useful for patient with animia. The physical and chemical components originate from the upper cretaceous aquifer.

Dead Sea Water

The surface of the Dead Sea lies at an elevation below 410 m b.s.l. Hence is is the deepest point on earth. The salinity of the water is around 10 times that of the oceanic water. The water is satiurated with salt with around 33 %. It seems that the curative properties are attibuted to the ratio of the different components and to the very high bromide concentration of 6.3 g/l which h is the highest known of surface water worldwide. In the Dead Sea area psoriasis and vitiligo (pigment disappearence) can be treated .It is the only treatment place for psoriasis for which no other means of treatment has yet been found.

Treatment in the Dead Sea area is not only achieved by using the water but is also related to the high oxygen content of the atmospheric air to the attenuation of UV radiate Ion due to the thick atmospheric layer overlaying the Dead Sea Area.

The possibilities of geothermal energy in Jordan

The main surface manifestsation of geothermal energy in Jordan is the thermal springs, which distributed along the eastern escarpment of the Jordan and Dead Sea graben (200 km). The origin of volcanic and thermal spring's activity has been a subject of investigation for sometimes.

The modern: plate tectonic theory can provide an adequate explanation for these phenomena. Duely the earth crust is divided into a few large and rigid plates, which float on the mantle, and move

relative toeach other at an average rates counted in centimeters/year. Geothermal fields are very common onplate boundaries, as the crust highly fractured and thus permeable, and sources of heat readily available.In such areas magmatic intusions some times with partly molten rock at Temp. Over1000 °C situated at few kilometers depth under the surface, heat up the ground water.

The hot water has lower density than the surrounding cold water and therefore flows up towards the surface along cracks and fractures. Mounting evidence suggests that the arabian plate is moving noth-eastward relative to the african plate and is coliding with the anadholian and the iranian plates. This collision was the cause of the uprising of the Taurus and Zagros belts at an earlier geological period.

The active Aqaba –Dead Sea transforming system consists, in its southern portion of a narrow graben limited by faults the graben displays a strong dissymmetry being morphologically and tectonically more complex on the eastern side. All the Jordanian potentially geothermal energy-producing zones belong to this portion. The movement of the arabian plate, probably lasting from upper oligocene and still going now, has included a network of fractures in Jordan, especially concentrated along the eastern side of the plate boundary.

Due to the active plate boudary, positive heat flow anomalies-are observed and evidenced by the numerous thermal springs located all over the eastern escarpment of Jordan and Dead Sea graben from Mukheiba in the north to Tafila in the south. However, the most important poassibility seems to be in the Zarqa Main-Zara zone, which are not only showqing positive heat flow anomalies and more or less important episodes of recent basaltic volcanim but also showing significant microearthquake activity in the recenty years. Other possibilities, the basaltic plateau of Jebel Ed-Druz which shows weak geothermal anomalies represented by thermal water in some deep boreholes such as Azraq Well.

In Jordan plateau, mainly in the area south of Queen Alia Airport, many shallow wells are producing relatively thermal water (<45 °C).

Origin of heat

A hot body of magma or a hot mass exists below the ZarqaMain-Zara within a depth down to 5-7 km; this provides the heat needed for the formation of a hypothermal zone above the intusion. Five basaltic vents were identified near Zarqa Main and one near Zara. According to the K-Ar age determination (E.H.Mckee, 1983) the ages of the extusion in the area range from 0.1-3.4my respectively.

Deep circulation of water in more or less a normal geothermal gradient

The deep fault zar. Main acts as conduitfor hot water from the deep confining sdst. Hypothesis was used to explain anomalously high heat flow on the West Side of the Dead Sea rift. (Eskstein, 1979).

The lateral movement of faults of the Dead Sea Rift and the effect of a thick layer of poorly sediment that may underlie Dead Sea and form a thermal blancket which reflect the heat to the rift margins.

Conclusions

Jordan enjoys in addition to its moderate climate many other curative resources like the before mentioned thermal springs. The Dead Sea water and the special radiation and climate of aqaba area. The thermal springs posseses high curative characters. The following conclusions can be drawn:

1. In general thermal springs in Jordan can be used for; gynacological, dermatological and allergies diseses, rheumatism, arthritis and ankylosis, muscle cramp and contraction, central and peripheral circulation troubles, urethritis, urinary lithaiasis, diuretic, chronic constipation and intestinal troubles, general health improvement sedative, nervous diseases, regulation of gland secretions.
2. The thermal waters have its source in lower Cretaceous sandstones and upper, Cretaceous limestones.
3. Most springs represent mixing of one or two members
4. The geothermal gradient is found to range from 3,6 – 4,5 °C/100m
5. The trace elements and radioactivity originate mainly from the lower Cretaceous sandstones and phosphatic rocks.
6. H_2S and CO_2 can be attibuted to reduction of sulfate in the presence of organic matter by anaerobic bacteria.
7. The Dead Sea water can be used for the treatment of psoriasis and vitiligo

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Lothar BECKEL

Satellite Remote Sensing for Geomedical Purposes

- Satellite Remote Sensing can support geomedical research with a substantial amount of geographical and environmental information which is important for the study and assessment of environmental impact to health.

- This presentation gives a shortened brief overview about a previous feasibility study dealing with the possibilities to correlate environmental phenomena with diseases.

1. The world is full of turbulences and phenomenas which cause illness and distribute pathogenes. The image shows the water vapor layer in the upper atmosphere.

2. The idea for the study was born during an observation flight in winter time with a light aircraft when a small airpolluting factory was noticed, which emits normal waste gases which concentrated some days later due to a changed weather situation (inversion) over the factory.

3. Other revisits, again some days respectively weeks later, showed the snow melting pattern under the previous waste gas cloud, which was caused by a fall out of soot, dust and resulting differences of light reflection by the snow, compared to the clean areas further away. Surface temperature rise of the impacted area lead to an earlier melting of the snow. This again was followed by an earlier greening of the surrounding meadows in spring time.

4. On many days of the year, specially between autumn and spring time southern winds (Föhn) are prevailing. In this situation the waste gases of the factory are blown over a well known tourist village.

5. It was assumed that similar situations could be observed in a larger scale from satellite. For this a test area in Upper Austria was selected, where heavy industries are concentrated. The area is
well known for inversions with long lasting smog situations.

6. Investigations in satellite image archives where successful. Several images could be found which showed similar phenomena.

   The region to be investigated after a fresh snow fall. The city is located at the Danube river in a small basin. In the north the area is surrounded by the so called **Bohemian Mass** a cristallin mountain areas with heights up to 900 and 1000 meters. Parallel to the Danube stretches from west to east the flat pre-alpine area slightly hilly, with small river beds, full of agricultural land, and a small city chain following the River Traun towards the south west. The black dots are forests. In the south the Alps are
   rising.

7. The same area during a several days old inversion. The central emission sources can be seen through the inversion cloud over the city area. The cloud distribution pattern is a regular one and can be observed very frequently.

After a change of the weather situation the snow melting pattern under the inversion cloud can be seen – it corresponds clearly with it.

8. With this images the idea was born to correlate the environmental respectively the smog situation with diseases. To study influenzas temperatures and humidity might be of interest. This information can be extracted from the thermal infrared band of the satellite data.

9. A first trial was made with death reasons of the inhabitants of this district. The number of cases had to be restricted to one year only, but was done for about 10 death causes. The study showed some interesting results - three of them are shown here:

10. Skin cancer correlates with the smog cloud. It has not been investigated what the reasons might be. For instance it could be one reason that the citizens are spending to much time on Italian beeches or in skiing areas without good sun protection.

11. A similar pattern shows up for lung cancer. - Smokers or industrial and city dust (including traffic exhaust gases)?

12. No correlation can be found for heart deaths. As a result of this pre-feasibility study more research will be done in the near future, together with medical investigators, which collected information over at least 10 years on living people, and which will be now correlated with satellite data information and environmental ground measurements.

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Friedrich MARSCH

Exploration Strategy for Mineralwater Resources

Abstract

The **methods of investigation** for underground water resources include a package of different very sophisticated methods, including proceedings from the petroleum prospection, the engeneering business, the applied geology, geophysics and geochemistry. Therefore an integrated team of experts is useful for the successful work in the field, the laboratory and the archive.

The combination of methods depends on the characteristic of the geological water reservoir, its solved mineral-components, and its eventual gas content. Especially in the circumalpine region much effort has to be spent on the different geological formations.

Nevertheless there are **risks** during the phases of exploration and production of mineral waters for sanitary purposes:

The geological risk (reservoir-size, permability etc.) in the stage of exploration, the technical risk (drilling depth, casing program) in the phase of drilling and the economical risk (production constance of quality and quantity, ecological dismiss) during the process of exploitation have to be taken in consideration.

Different **possibilities of constructing underground production buildings** for water resources have a considerable effect on the cost side of errection and working of the plant: conventional drilling wells for mineral waters in sedimentary basins, tunnels for thermal water in mountainous regions, special constructions for sanitary gas production (CO_2, H_2S, Rn) may be examples. Advanced technologies show the way for propriate resources management.

Long term protection of the reservoir rock is necessary for the prevention of man-made pollution influence, and for minimizing geological hazards. Important targets are the recognition of aquifer alteration, supply of mineral water resources, purity from micro-organics and sediment of the produced fluid, constant behavior in chemical characteristic, simplification of upkeep process, and the delay of eventual reconstruction.

Last stage may be the **readjustment** of the underground building in the case of sanitary or production problems. The right evaluation of above mentioned data supports the quick and secure handling of proceedings for the future successful production of additional resources.

1. DEFINITIONS

"Exploration strategy" means: What should be done for the successfull, long time production of the underground resource, which is the basis of the course of treatment in a rehabilitation centre.

"Mineral water resources" means the natural underground water for the curative use of sanitary purposes (spa, inhalation, drinking) of sick people, who may need these by advice of medical doctors. Mineral waters are produced from geogene aquifers. These reservoirs mean the connection and interaction of

- rock mass, porosity, fracturing;
- fluid containing dissolved minerals ± gases;
- bacteria and microbes.

So the terminus technicus "mineralwater" in this article does not mean the german title "Mineralwasser"!

2. METHODS OF INVESTIGATION

The **methods of investigation** for underground water resources include a package of different very sophisticated methods (Fig.1, MARSCH 1996a), including proceedings from the petroleum prospection, the engeneering business, the applied geology, geo-physics and geochemistry. Therefore an integrated team of experts (geologist, geo-physicist, hydrologist, technician, analytical chemist, physician) is useful for the successful work in the field, the laboratory and the archive (MARSCH & KOLLMANN 1996).

The combination of methods depends on the characteristic of the geological water reservoir, its solved mineral-components, and its eventual gas content. Especially in the circumalpine region much effort has to be spent on the different geological formations.

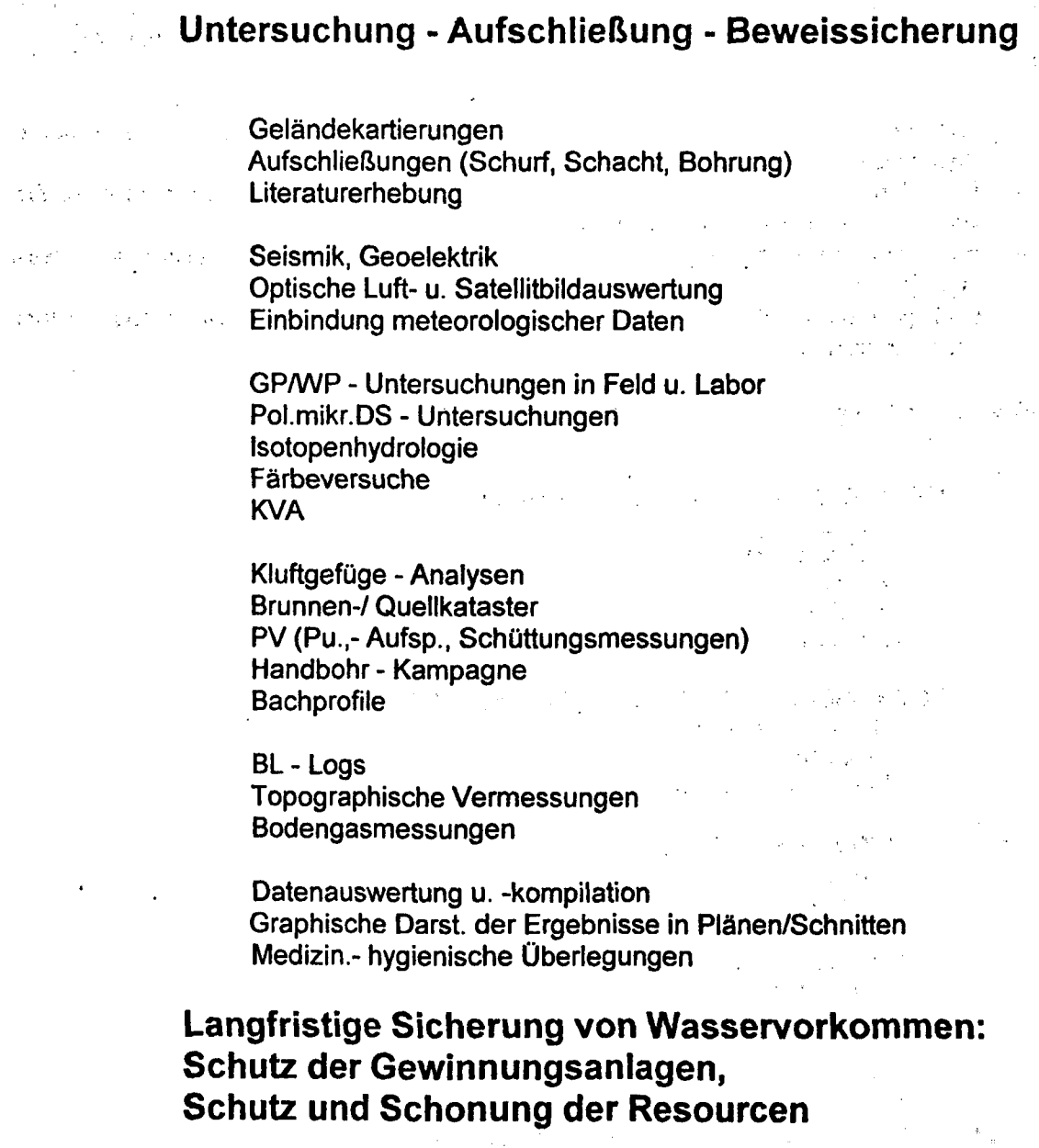

Fig.1: Methods for investigation and exploration of underground water resources

3. RISKS AND PROBLEMS

Nevertheless there are **risks** during the phases of exploration, production and exploitation of mineral waters for sanitary purposes (see Fig.2)

The geological risk (reservoir-size, permability etc.) in the stage of exploration, the technical risk (drilling depth, casing program) in the phase of drilling (MARSCH et al. 1990, MARSCH 1996b) and the economical risk (production constance of quality and quantity, ecological dismiss) during the process of exploitation have to be taken in consideration.

If the right evaluation of risks is missed, planning and errection of engineering constructions in the circumalpine landscape (MARSCH 1999) may cause special **problems** in the stages of mineralwater exploration and production:

- delay of handling after cavity opening without wall support may cause the distension of slope mass-movement;
- far sinking of the water table in the phase of production may cause an input of surface water and O_2, reduction of mineralisation and change of gas content;
- no surface seal or bad surface seal against soil and atmospheric influences may cause organic alteration by influence of microbes;
- inadequate timing of different measures on the well - locations may cause delay of time, get complications, wasting money.

In every case the negative effect means costs are rising up.

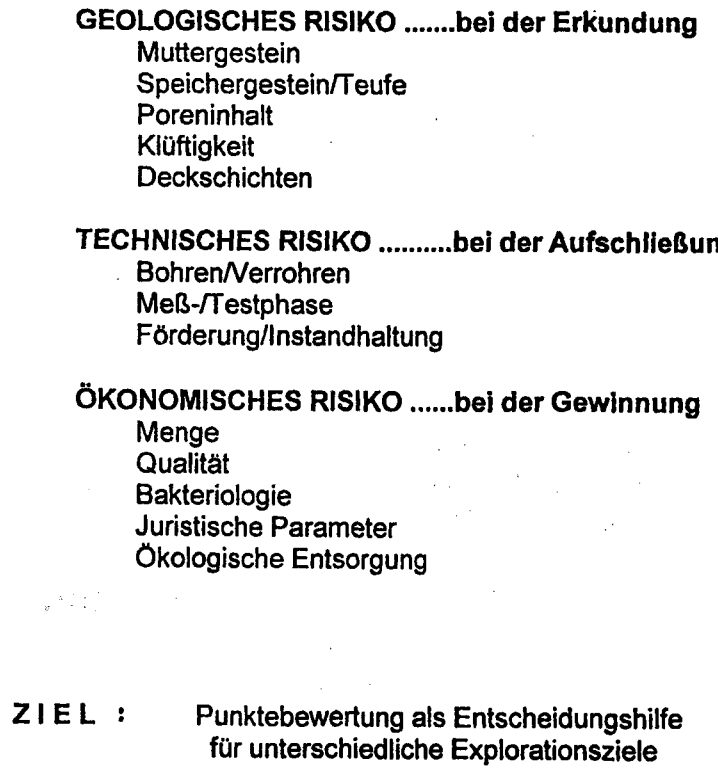

Fig.2: Geological, technical and economical risks in the stages of exploration, production and exploitation of mineral water resources

4. TYPES OF CONSTRUCTION BUILDINGS

Different **possibilities of constructing underground production buildings** for water resources have a considerable effect on the cost side of errection and working of the plant:

- The upstream part contains measures like slit, shaft or drilling borehole. Different engineering constructions: flat wells, deep drilling wells, deviated wells, horizontal wells, or even special constructions are used as a part of the underground production building (exploration of water resources);
- wall casing material and diameter, filter type and pump system must be adequate to the water-mineral-gas type (production of water resources);
- The downstream part is the tunnel system in the alpine region, also micro tunnelling, furthermore distribution pipelines, and eventual work over treatment plants (STEHLIK 1996) (transport and work over of water and gas resources).

5. LOGISTIC AND COST STRUCTURE

All these parameters discussed above influence the **logistic and cost structure of the mineral water exploration** process. Five steps of decisions are important (Fig. 3):

- Ranking of priorities (data collection and feasibility);
- Governmental restrictions (technical project planning);
- Erection of the first engineering construction;
- Evaluation of the discovered resource (which water for which purpose);
- Medical expertise for the right application.

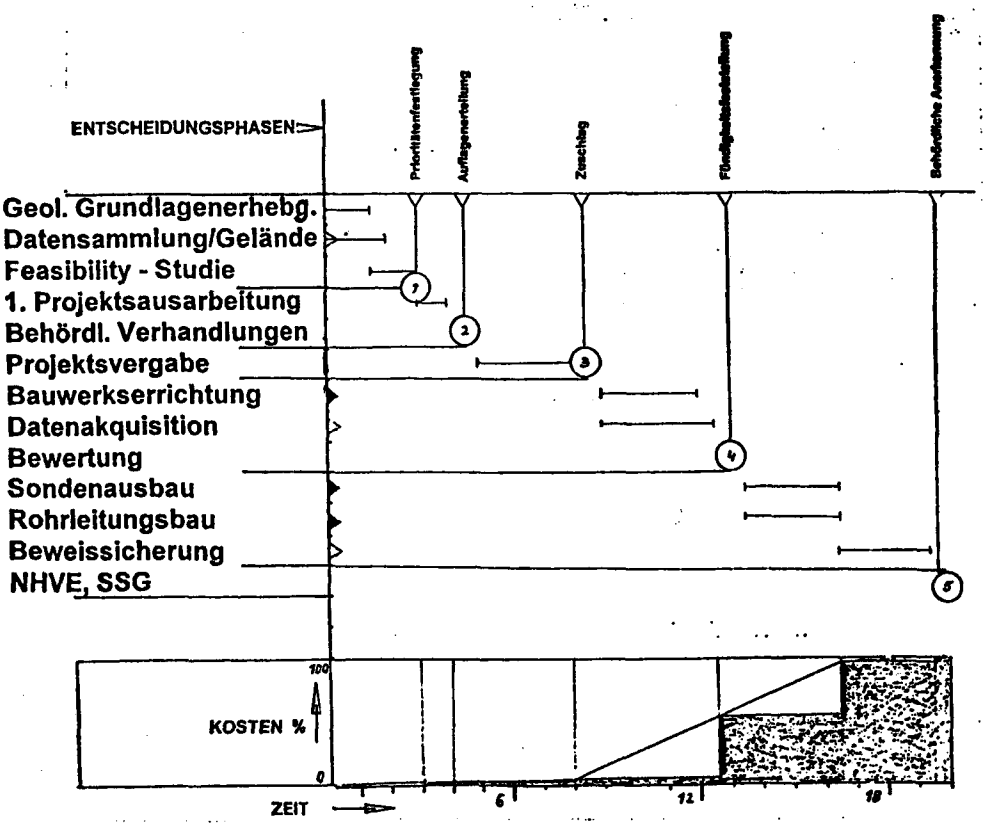

Fig.3: Logistic of the mineral water exploration

6. LONG-TIME-EVALUATION AND LONG-TERM-PROTECTION

Especially the **long-time-observation** of the underground reservoir is necessary for the propriate resources management:

- production rate (ls^{-1}) and cumulative production (m^3)
- sinking of water table (m below surface)
- eventual change of mineralisation (mgl^{-1}, μScm^{-1})
- temperature development (°C)
- gas content (%)
- isotope content (^3H, ^{14}C etc)
- synchrone observations on neighbour wells

versus time over some months of a mineral water reservoir under investigation.

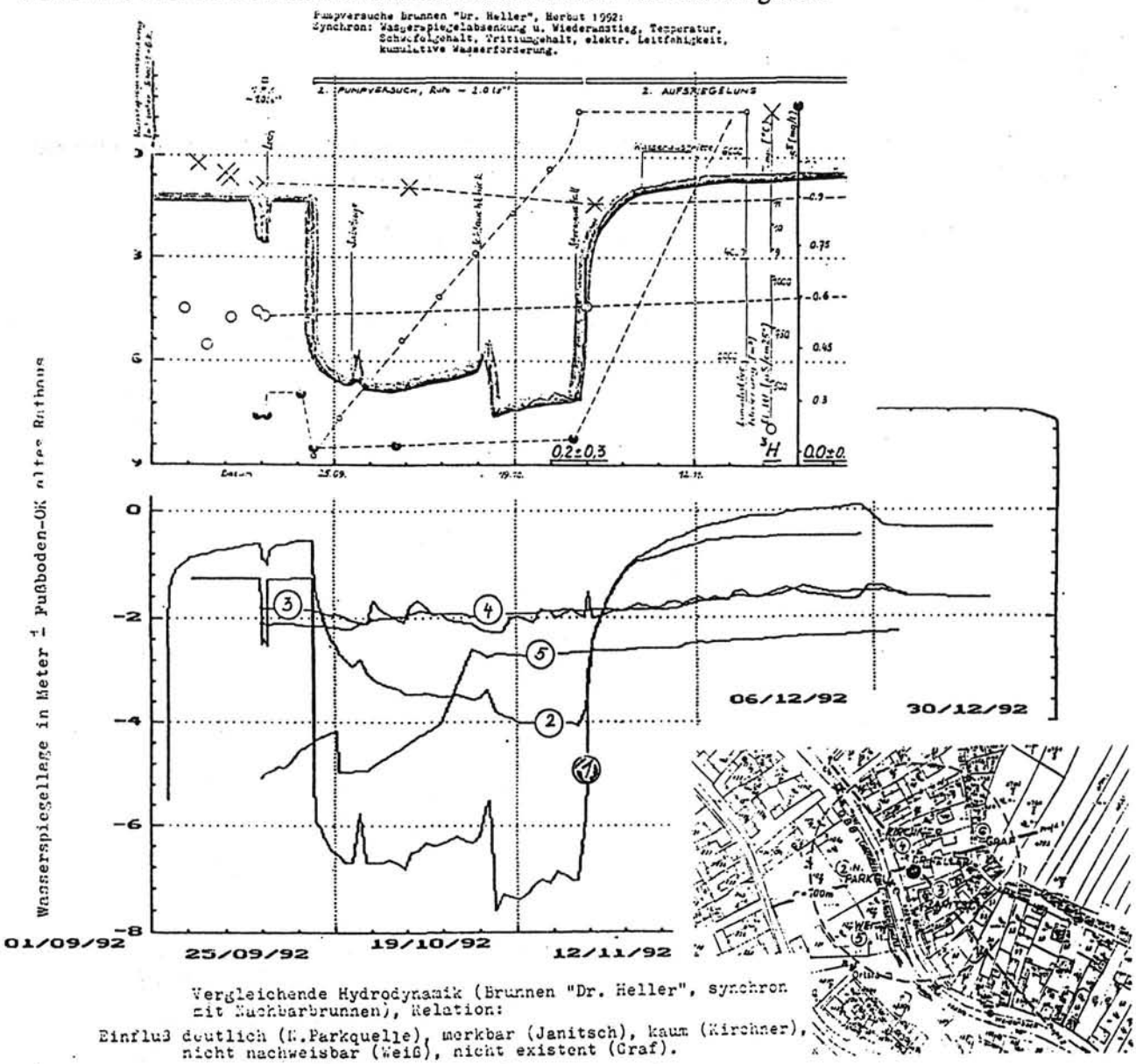

Fig.4: Long time evaluation of mineral water resources

The isotope element distribution can be used for additional evaluation of age and origin of the

mineralized formation water. This evaluation is necessary to protect the production system, and to take care of the underground.

Long term protection (MARSCH 1997) of mineral water resources and the reservoir rock is necessary for the prevention of man-made pollution influence, and for mini-mizing geological hazards. Important targets are

- recognition of / prevention from aquifer alteration
- supply of water resources
- purity from micro organics and sediment of the produced fluid
- constant behavior in chemical characteristic
- simplification of upkeep process
- delay of eventual reconstruction

Last stage may be the **readjustment** of the underground building in the case of sani-tary or production problems. The right evaluation of above mentioned data supports the quick and secure handling of proceedings for the future successful production of additional resources. Advanced technologies show the way for propriate resources management.

7. INNOVATIVE CONTRIBUTIONS OF THE GEOLOGIST

In this publication the **innovative contributions of the geologist** to all these problems should also be mentioned:

- The possibility to applicate deep wells for special purposes.
- The application of technical progress to further production from aberrant aquifers:
  - from crystalline rock types;
  - from nappe boundaries or steep dipping tectonic fault systems (MARSCH 1995);
  - from aquitards;
  - from layered fluid reservoirs.
- The reinjection of fluids and gases for water disposal or pressure support in producing aquifers.
- The exploration for curative gases (CO_2, H_2S, Rn; MARSCH 1998) .
- The security protection of existing resources.

Fig. 5 finally shows the possibility for the organizing structure for special field projects in the discipline of fully integrated geomedicine: The connection between different contractors (drilling companies, logging specialists, laboratory chemists etc.), the report to the governmental representative, the scientific, technical and economical advices of the team of experts, and the cost control for the orderer under the management of a licensed technical planning bureau.

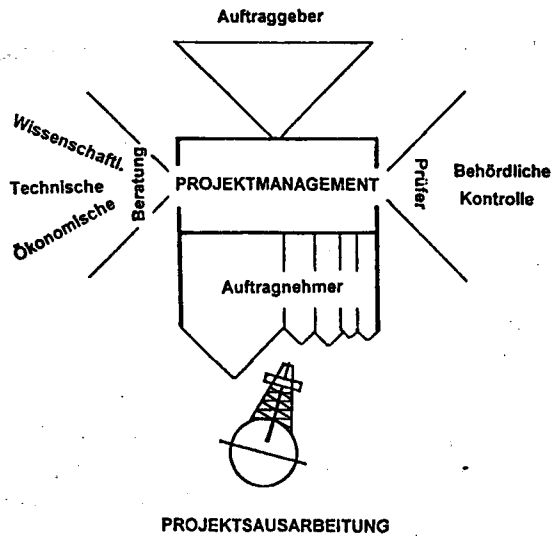

Fig.5: Possibility for the organizing structure for special field projects

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Manfred SAGER

Selenium - Occurrence and Cycling in Agricultural Matrices

Abstract

In soils and green plants of Central and Northern Europe, selenium contents is lower than in most parts of the US. Within the Austrian soil monitoring programme, median values for total selenium in aqua regia extracts of soils sieved < 2 mm have been found within the range 0,11 - 0,41 µg/g. No soils enriched in selenium were found. In Austrian diet, daily intake of selenium has been determined within a range of 27-68 µg/day (mea: 48 µg/day), which is rather low. According to the Recommended Daily Allowances in the US, the average daily intake should be 50 - 200 µg/day, and according to the German Society of Nutrition, it should be 20 - 100 µg/day. In order to promote optimum growth and resistance to various illnesses, selenium as sodium selenite is added to commercial animal feedstuffs up to a total contents of 0,5 g/g. Control of this threshold value is one of the main tasks of the Office and Research Centre of Agriculture in Vienna. The selenite may be partially reduced by other components of these mixed diets to non- leachable forms, presumably elementary selenium. Excess selenium is excreted, and can lead to enhanced selenium levels in manure and in sewage sludges. Organic amandments thus cover a wide and still unpredictable source of selenium enrichment for agricultural soils. Under reducing conditions, selenium can be partially volatile on drying. Freeze drying significantly improved selenium regain from liquid manure. The standard method for the analysis of sewage sludges starts from the dried sample, and applies aqua regia. For manure, drying and subsequent ashing in presence of magnesium nitrate has been preferred. In order to study the soil - plant - transfer of selenium in non- contaminated fields, 68 samples of chernozem soils and correponding barley plants were sampled just before harvest at the Parndorfer Platte (Burgenland) in June 1992, just before the construction of the highway. Selenium transfer to the barley grains did not yield a constant ratio versus plant selenium.

Addition of sodium selenate to inorganic fertilizers of the NP or NPK type aiming to enhance selenium levels in cereals, like it has been done in Finnland, has been successfully prevented by the Austrian Ministry of Health. Pot and field experiments showed significant increase of selenium in the eatable parts of wheat, maize and potatoes, without change of the composition of other inorganic constituents. After hydrolization of these cereals with pronase in citrate/phosphate buffer pH 7,3, selenium species were separated on a Hamilton PRP-X100 anion exchange column in citrate buffer pH 5, and detected with ICP-MS. The excess selenium in the plants fertilized with sodium selenate, has been found largely metabolized as seleno-methionine.

In case, sodium selenate would be mixed to some sorts of fertilizers as a micronutrient, like cobalt or molybdenum, prevention of selenium losses because of migration to deeper layers and to the groundwater was investigated in soil columns. From fertilizer solution, selenium was largely fixed, and constantly released to deeper layers as non-selenite selenium. Like for sulfur, drying and aeration periods enhance selenium mineralization, thus increasing its mobility.

For the future, determination of metabolized selenium forms eluting from soil columns with respect to variations in aeration and nitrogen- supplementation conditions (nitrate, ammonia, organic amendments) are planned by HPLC-ICP hyphenated techniques. A further question would be to elucidate reactions of selenite additives with components of feedstuffs on storage.

In soils and green plants of Central and Northern Europe, selenium contents is lower than in most parts of the US. The nutritional status of the Austrian population is regarded to be low, but still adequate. The daily selenium intake has been determined to be within the range 27 - 68 µg/d, with a mean of 48 µg/d (WILPLINGER, PFANNHAUSER 1997). According to the Recommended Daily Allowances in the US, the average daily intake should be 50 - 200 µg/day, and according to the German Society of Nutrition, it should be 20 - 100 µg/day.

Within this brief report, selenium data from the last decade obtained in our Research Centre, are reviewed. More information can be obtained from review papers (SAGER 1994).

Selenium in soils

Within the Austrian soil monitoring programme, median values for total selenium in aqua regia extracts of soils sieved < 2 mm have been found within the range 0,11 - 0,41 µg/g (Tab. 1). No significant differences between soils developed on various geological facies, have been observed. There might be some depletion in older soils, like this has been markedly observed in case of zinc. No locations enriched in selenium up to toxic levels were found.

Geological unit	Sample number	Median mg/kg Se
Postglacial sediments	173	0,30
Glacial sediments	179	0,25
Loess	280	0,21
Molasse	78	0,26
Flysch	94	0,30
Limestone of Northern Alpine Zone	80	0,31
Schists and gneisses of Bohemian Crystalline	102	0,23
Granites of Bohemian Crystalline	113	0,16

Tab. 1: Selenium background values in soilsLower Austria and Burgenland 0-20 cm aqua regia, air - dried soil < 2 mm

Selenium transfer from soil to crops

In order to study the soil - plant - transfer of selenium in non - contaminated fields, 68 samples of haplic chernozem soils at the Parndorfer Platte /Burgenland with corresponding barley plants sampled before harvest in the middle of June have been investigated. The site is unique for Central Europe, because there has been no settlement after retreat of the Romans at the begin of the 5th century, and all trace elements at background levels. There are no surface waters at an area of 25x40 km, and soils of the same type throughout. Topsoils and subsoils were not significantly different. There was no significant correlation between barley grain selenium - soil selenium (r = 0,202). Wheat and maize samples grown without the addition of selenate to the fertilizers, have later been found 10 times lower than barley, i e. within the range 4-10 µg/kg Se.

		median	range	n
Soil 0 - 25 cm	selenium	0,23 mg/kg	0,17-0,34	68
	humic substances	2,9 %	2,3-3,8	
	carbonates	0,5%	< 0,2 - 4,8	
	clays	27%	23-29	
Soil 40 - 60 cm	selenium	0,26 mg/kg	0,21-0,35	6
Barley grains	selenium	0,046 mg/kg	0,024 - 0,088	68

Tab. 2. Soils from Parndorfer Platte before construction of the highway Vienna – Budapest corresponding barley samples before harvest, 15.-17.6. 1992

Selenium in animal feedstuffs

In order to promote optimum growth and resistance to various illnesses, selenium as sodium selenite is usually added to commercial animal feedstuffs up to a total contents of 0,5 mg/kg. Control of this threshold value is one of the main tasks of the Office and Research Centre of Agriculture in Vienna. During storage, the selenite may have been partially reduced by other components of these mixed diets to non-leachable forms, presumably elementary selenium. (Leaching was done with 0,001M formic acid). Separation of eluted selenium species was done on an anion exchange column, operated via HPLC with element- sensitive detection by ICP-MS.

	Median	Max	Min
Total Selenium µg/kg	929	3932	524
Selenite µg/kg	347	1104	70
Selenate µg/kg	34	71	0
Residue µg/kg	503	2810	291
% Selenite	28,3	53,5	13,4
% Selenate	0,0	3,7	0,0
% Residue	53,6	75,8	33,7

Tab. 3. Selenium speciation in Animal Feedstuffs after Storage

Selenium in excrements

From farmed animals, excess selenium is excreted, and ean lead to enhanced selenium levels in manure and in sewage sludges (CAPPON 1991: Se in US-sewage sludges was 0,4-9,6 mg/kg d.w.). Organic amendments thus cover a wide and still unpredictable source of selenium enrichment for agricultural soils. Whereas there have been no problems with plant material, animal feedstuffs and animal tissues, under reducing conditions, selenium can be partially volatile on drying; the boiling point of the metabolite dimethylselenide is only 58 °C. Data found in the literature or in reports and certificates, however, have been got always from the dried samples. Addition of aqua regia to dried and wet samples can thus lead to different results in both directions; too much water prevents oxidation of elementary selenium and selenides. Addition of solid sodium thiosulfate led to an almost complete regain of selenium in the drying procedure, but as the speciation of selenium in these materials is still unknown, the mechanism is not understood yet. Freeze drying significantly improved selenium regain from liquid manure, but methylated species are still lost. The standard method for the analysis of sewage sludges starts from the dried sample, and applies aqua, regia. For reasons quoted above, however, we have changed our standard procedure for the analysis of manure and organic amendments towards drying and subsequent ashing in presence of magnesium nitrate (Tab. 4).

	median mg/kg	range	year	n
Manure after biogas production	0,74	-	1998/99	1
Solid manure from pigs	3,09	1,08-7,7	1998/99	25
Liquid manure from pigs	1,31	1,16-1,41	1998/99	4
poultry dung	1,33	0,54-1,78	1998/99	6
liquid manure from fattening cattle	0,125	0,12-0,13	1998/99	2
liquid manure from dairy cows	0,825	0,804 - 0,846	1998/99	2
sewage sludge dried	1,25	0,33-10,8	1992/93	16
sewage sludge wet	1,89	0,41-30,1	1992/93	18

Tab. 4. Selenium in organic amendmentmanure dried in presence of $Mg(NO_3)_2$ - muffle fumace 560 °C sewage sludge dried without additive, aqua regia wet sewage sludge + aqua regia, calculated for dried sample

Selenium in fertilizers

Addition of sodium selenate to inorganic fertilizers of the NP or NPK type (16 mg/kg Se or 30 mg/kg Se) aiming to enhance selenium levels in cereals, like it has been done in Finnland, has been successfully prevented by the Austrian Ministry of Health. Pot and field experiments showed significant increase of selenium in the edible parts of wheat, maize and potatoes, without change of the composition of other inorganic constituents. After hydrolization of these cereals with pronase in citrate/phosphate buffer pH 7,3, soluble selenium species were separated on a Hamilton PRP-X100 anion exchange column in citrate buffer pH 5, and detected with ICP-MS. The excess selenium in the plants fertilized with sodium selenate, has been found largely metabolized as seleno-methionine.

Vertical, transport of selenium in soil columns.In case, sodium selenate would be mixed to some sorts of fertilizers as a micronutrient, like cobalt or molybdenum, prevention of selenium losses because of migration to deeper layers and to the groundwater was investigated in soil columns. From artificial fertilizer solution, selenium was largely fixed. Daily addition of water to the soil columns of

about 0,1 pore volumes simulated rain events. The eluates were dried and ashed in presence of magnesium nitrate and potassium permanganate to yield total selenium contents, which were much higher than selenite. Like for sulfur, there was a constant release of selenium from the column, which was enhanced after drying and aeration perlods (Tab. 4).

Perspectives

Future projects speciation of mobile selenium forms eluting from soil columns with respect to variations in aeration and nitrogen - supplementation conditions (nitrate, ammonia, organic amendments) are planned to be performed by HPLC-ICP hyphenated techniques. A further problem to be worth while investigated would be to elucidate reactions of selenite additives with components of feedstuffs on storage. The last and most difficult task will finally be to investigate the selenium species and turnover reactions in organic amendments and sewage sludges.

Nutrient salts per hectare		absolute amounts
160 kg/ha N as NH_4NO_3		
320 kg/ha P_2O_5 as $Ca(H_2PO_4)2{\cdot}H_2O$	113 mg Ca	175 mg PO_4-P
200 kg/ha K_2O as K_2SO_4 + KCl	208 mg K	17 mg SO_4-S
2 g/ha B		2,5 mg B
0,8 g/ha Mo and V		1,0 mg Mo and V
0,4 g/ha As and Se		0,5 mg As and Se

Tab. 5. Selenium mobility in the soil column 4 times 3 soils, 5 kg each; haplic - calcic - gleyic chernozems non-saturated flow from top to bottom in the dark 2 times each day 0,1 pore volwnes = 150 ml = annual precipitation within 2 months Pore volume determination: peak of Cl of KCl Addition of selenite in NPK - fertilizer

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Robert SAJN and Simon PIRC

Distribution of Chemical Elements In Urban Sediments in Slovenia (Extended Abstract)

The goal of the study work was to assess the distribution of chemical elements in anthropogenic urban sediments (street sediment, house and attic dust) in Slovenia, and to define them with respect to geology.

Distributions of 27 chemical elements (Al, Ca, Fe, K, Mg, Na, P, Ti, Ba, Cd, Co, Cr, Cu, La, Mn, Nb, Ni, Pb, Sc, Sn, Sr, Th, V, Y, Zn, Zr and Hg) were estimated, essential geochemical association established and their areal distribution in urban sediments across the countryside and six larger towns in Slovenia determined.

The geochemical properties of urban sediments were compared to those of sampled natural materials - soils and overbank sediments - and evaluated in terms of their elemental contents and elemental associations. As based on comparisons of urban and natural sampled materials with the factor analysis, in Slovenia five geochemical patterns of elemental distributions were established.

The first group comprises Al, Fe, K, Ti, La, Mn, Nb, Sc, Th, V and Y. The Slovenian averages of these elements in house and attic dust are much lower than in soil and overbank sediment. In the countryside, these elements have a similar distribution in overbank sediment, in house and attic dust. The highest elemental values occur in the NE of Slovenia. With respect to lithology, the highest medians of Al and V were found in house and attic dust in the area of igneous and metamorphic rocks (Pohorje) and molasse-type deposits of the Pannonian Basin, and the lowest in the W, in areas of outcropping flysch and carbonate rocks (fig. 1a - 1d).

The contents of these elements in attic and house dust in towns oscillate around the Slovenian averages. The highest values of Al, K, Fe, Ti, Mn, La, Nb, Sc, Th and V occur in the urban area of Maribor which supports the hypothesis of association of these elements with weathering of igneous and metamorphic rocks. High values of Fe, Mn and Nb in the Jesenice area seem to be influenced by the metallurgy. The principal source of these elements is most likely the weathering of rocks

The second group associating Cd, Cu, Pb, Sn, Zn and Hg represents the anthropogenically introduced chemical elements. For Slovenia, the averages in attic and house dust are for factors higher than in soil and overbank sediment. Most striking is the similarity of areal distribution of these elements in the countryside between the attic dust and overbank sediment. High values mainly of Cd, Pb and Zn in Lower Styria are ascribed to the influence of Mežica mines and smelter, and of the Celje zinc smelter. High Hg in the west in all sample media is a consequence of centuries of operation of the Idrija mercury mining smelting, and of military activities during the first World War (fig. 2a - 2d).

In towns, the contents of Cd, Cu, Pb, Sn, Zn and Hg in all analysed materials are for factors higher than the Slovenian averages. Interesting exceptions are the mercury means in house and attic dust of towns that are lower than the Slovenian averages. Very high contents of Cd, Cd, Cu, Pb, Sn and Zn in all sampled materials are characteristic for the town of Celje which should be explained by operation of the Celje zinc smelter. High mercury in Koper might be the result of deposition of high Hg in the sediment of the Soca river to the Gulf of Trieste. The contents of Cd, Cu, Pb, Sn, Zn and Hg in urban sediments vary much within the settlements, and Cd, Cu, Pb, Sn, Zn and Hg in attic dust display also significant regional trends.

The third group comprises Cr and Ni. Their highest contents among all sampled materials were found in house dust. Cr and Ni, and in part also Sn and Zn are the chemical elements most typical for households. In the countryside, they are influenced by natural (high contents in the flysch areas in SW and crystalline rocks in NE) and anthropogenic factors (high values in Upper Carniola, as a result of metallurgy in Jesenice).

Similarly as Cr and Ni are associated to towns also Mn, Fe, Nb and Co. Their high values are localized mainly to the iron metallurgy centre of Jesenice. Characteristic for distributions of these elements are insignificant differences of contents between various sampled materials within the

settlements in contrast to higher differences between the settlements.

The fourth group unites Na, Ba and Sr. Typical are the highest contents in house dust, and very small variance of contents with sampled materials. The contents seem to be dependent upon the amount of plagioclases in samples. In the countryside Na, Ba and Sr are almost equally distributed among house and attic dust, and overbank sediment. The highest contents were found in NE Slovenia. Na, Ba and Sr especially in attic dust reflect well the regional geochemical trends. Significant differences within the settlements are attributed to household activities. With respect to lithology the highest elemental contents were found in house and attic dust in regions of igneous and metamorphic rocks (Pohorje), and their lowest contents on carbonate rocks.

In towns, a similar association consisting of Na, Ba and La was established. High values in the Maribor area are attributed mainly to geogenic causes. The highest differences were found between the sampled materials and between towns.

The fifth group combines Ca and Mg, the elements typical of carbonate rocks. In the countryside, their lowest contents were detected in soil, and the highest in overbank sediment. As the source for these elements in attic and house dust the decomposition of construction materials is suspected. In towns high Ca and Mg were found in street sediment, owing to sanding the streets in wintertime.

An alarming fact are the very high contents of Cd, Cu, Pb, Zn, Sn and Hg in house dust. They exceed much their levels in natural sediments. The urban sediments, especially the house dust, are substances to which the humans are incessantly exposed. Dust particles containing heavy metals enter human organism through swallowing or inhaling, and they accumulate in it. Several authors established significant associations between the heavy metal contents in house dust, and concentrations in body liquids (blood, urine). There of direct hazards to population in Slovenia may be derived. High contents of heavy metals in urban dust are potentially dangerous especially to children. Small infants are the most endangered group because of their higher intake of dust than for adults, and owing to their higher sensitivity to the influence of heavy metal.

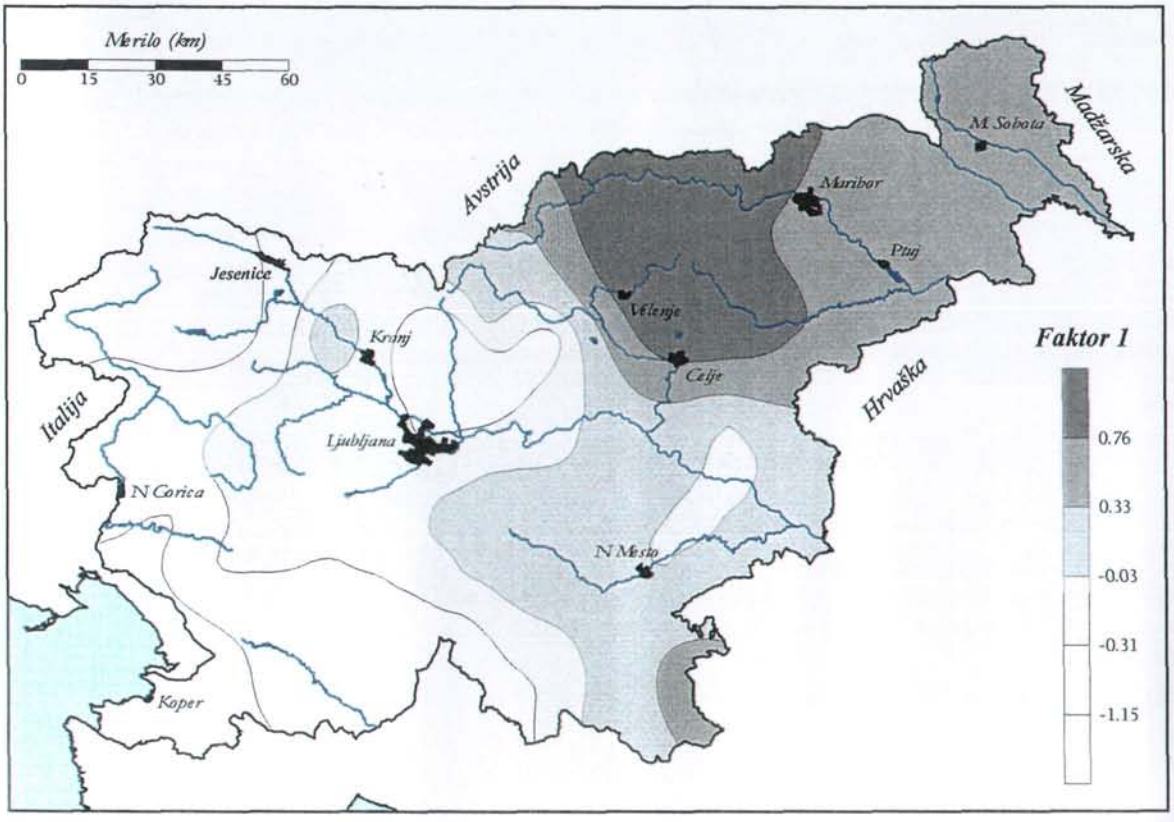

Fig. 1a: Distribution of factor 1 (Al, K, Ti Sc, Y, V, Th, Fe, Nb, -Ca and -Cu) in attic dust

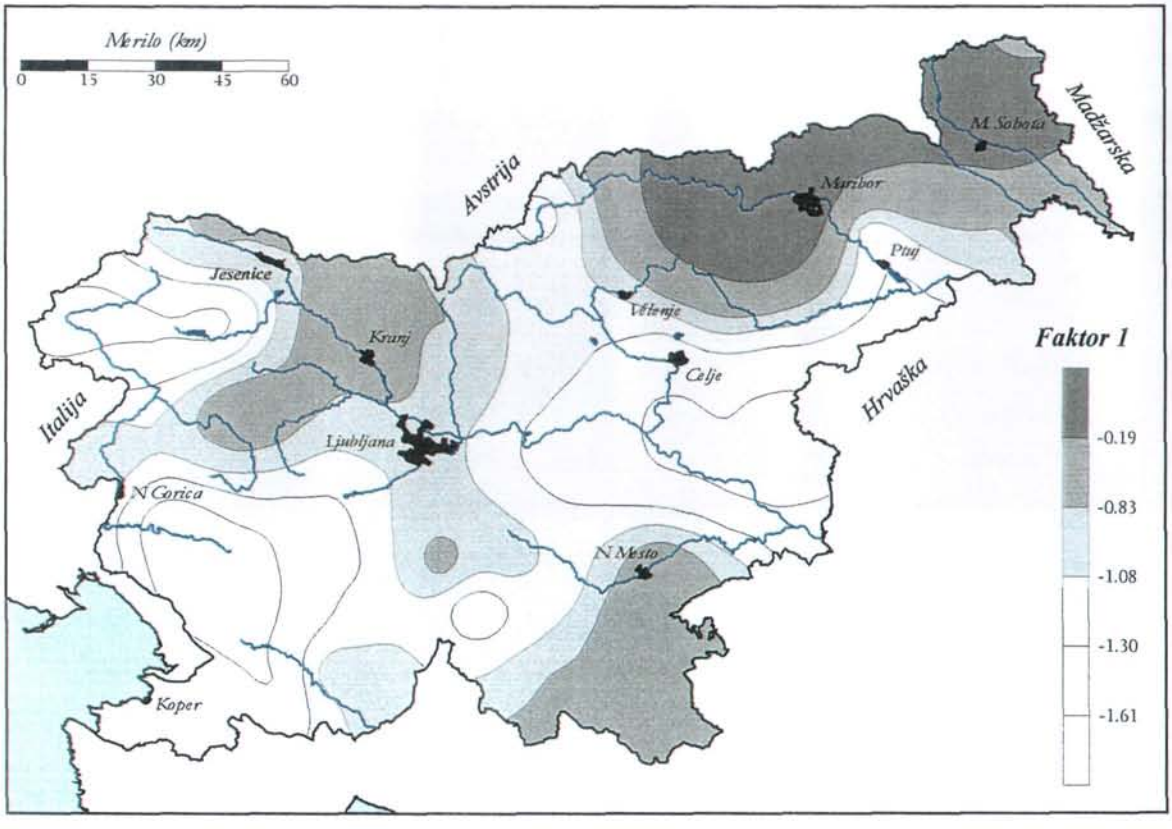

Fig. 1b: Distribution of factor 1 (Al, K, Ti Sc, Y, V, Th, Fe, Nb, -Ca and -Cu) in household vacuum cleaner dust

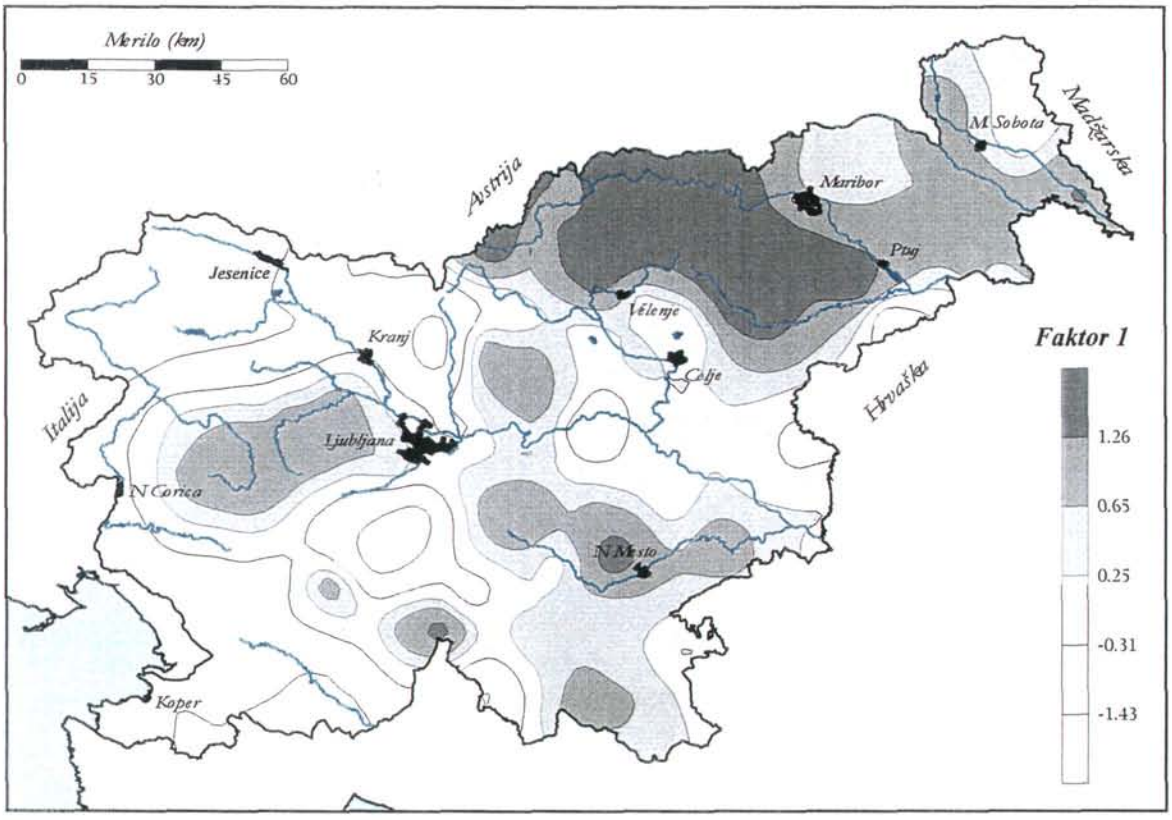

Fig. 1c: Distribution of factor 1 (Al, K, Ti Sc, Y, V, Th, Fe, Nb, -Ca and -Cu) in overbank sediment

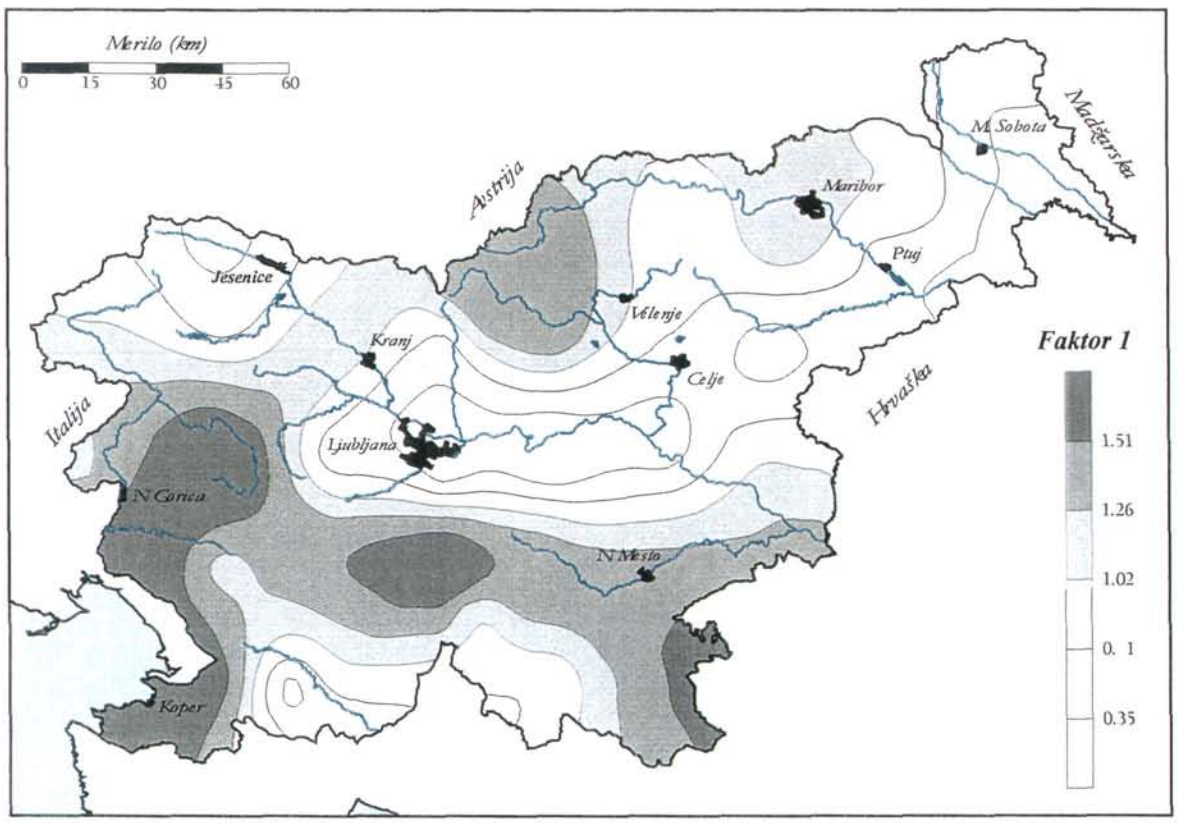

Fig. 1d: Distribution of factor 1 (Al, K, Ti Sc, Y, V, Th, Fe, Nb, -Ca and -Cu) in soil

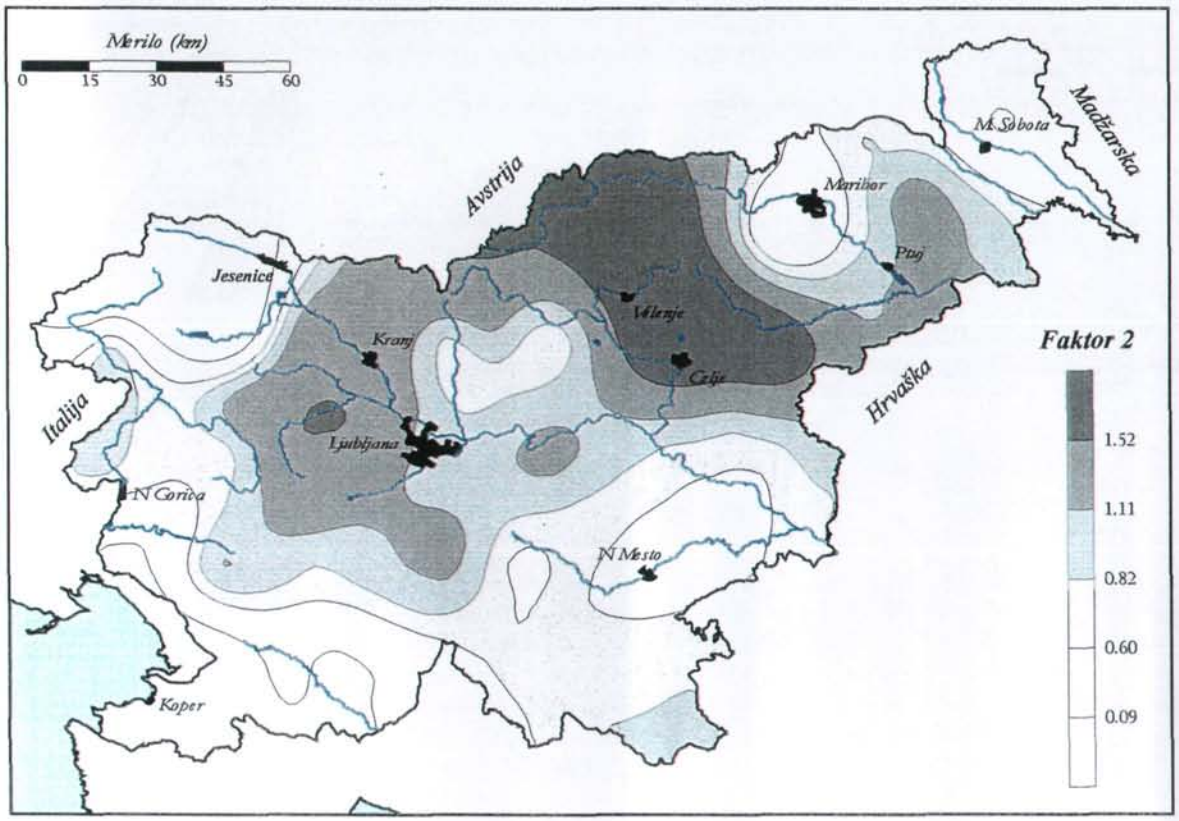

Fig. 2a: Distribution of factor 2 (Cd, Cu, Pb, Sn, Zn, Hg and -Sc) in attic dust

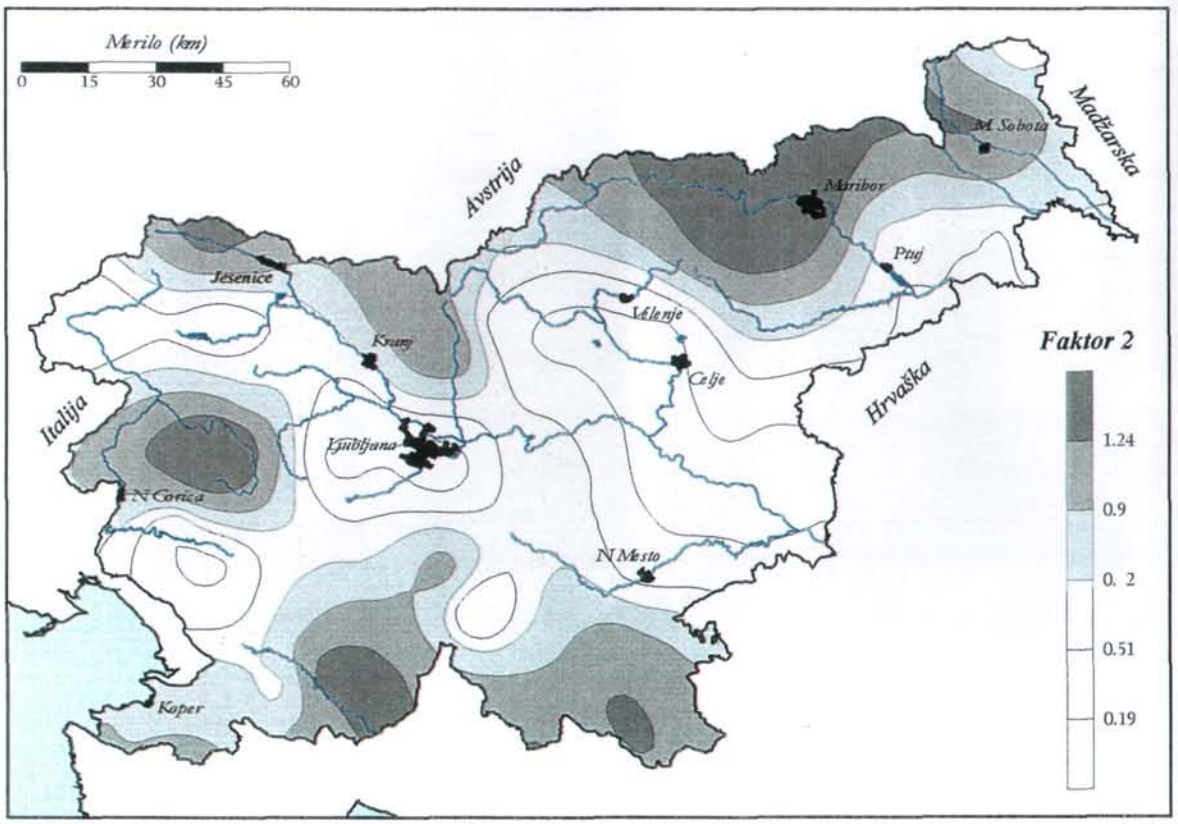

Fig. 2b: Distribution of factor 2 (Cd, Cu, Pb, Sn, Zn, Hg and -Sc) in household vacuum cleaner dust

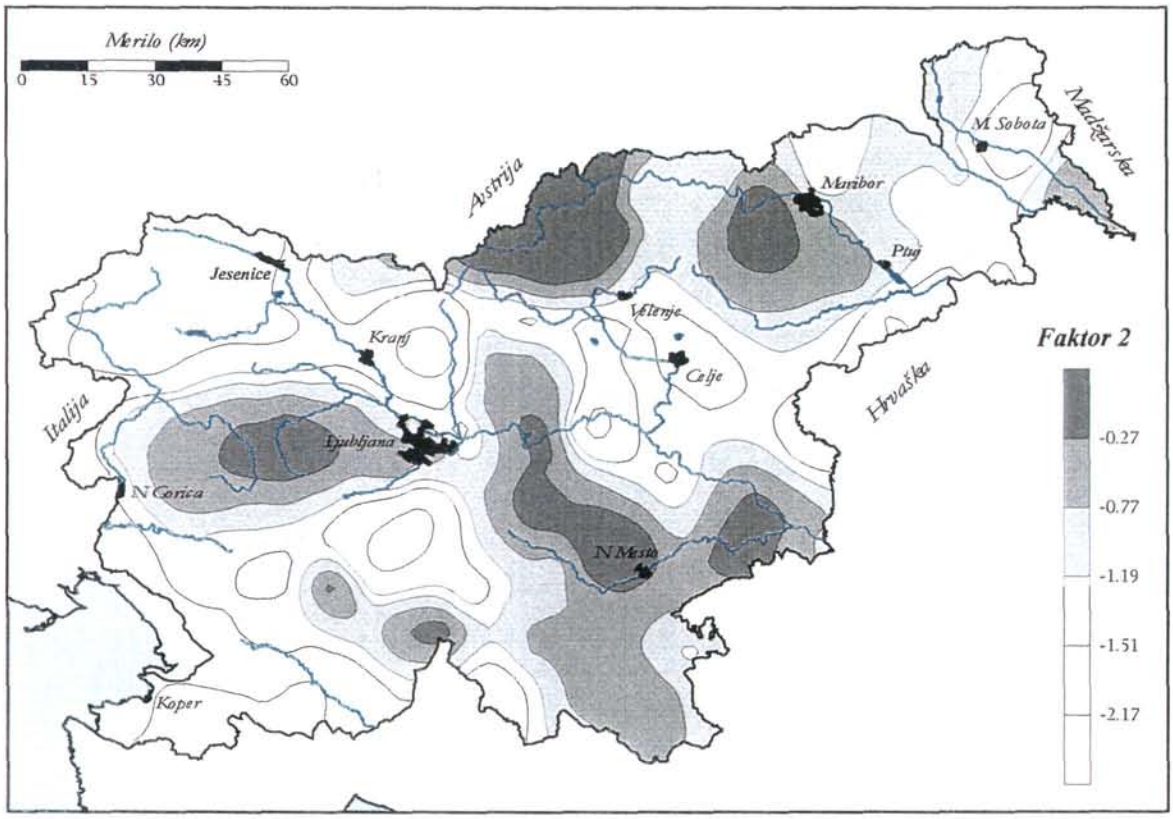

Fig. 2c: Distribution of factor 2 (Cd, Cu, Pb, Sn, Zn, Hg and -Sc) in overbank sediment

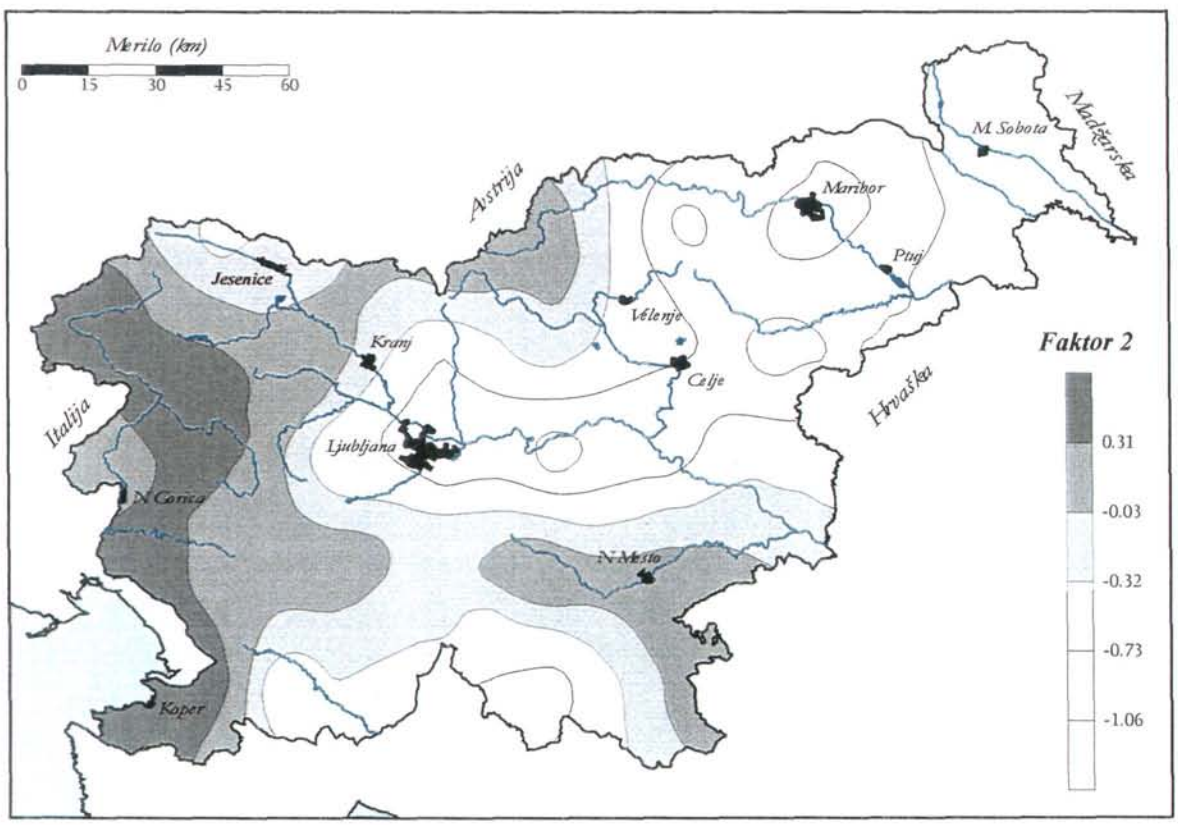

Fig. 2d: Distribution of factor 2 (Cd, Cu, Pb, Sn, Zn, Hg and -Sc) in soil

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R. PAVUZA and K. MAIS

A Speleometerological Database for Speleotherapy in Austria

Speleotherapy is a common tool for the treatment of several diseases like different kinds of Bronchitis and Rheumatism. Despite the fact that this method is widely used in most Eastern European countries as well as in Germany only a few locations exist in Austria so far (Badgastein, Oberzeiring, Bad Bleiberg). All of them are situated in abandoned mines or tunnels.

On the other hand some 13 000 caves are documented in the Austrian cave register currently. No natural cave is utilized permanently as a station for speleotherapy but a few are visited by patients on a rather non-regular base under supervision of a local physician.

So far there is no information-system available where interested physicians or speleologists could gather data about basic cave climate parameters of a certain cave. A database - called SPELMED - is now in preparation, compiling different data collections of previous databases (for cave temperatures, radon content, hydrochemistry and others) and combined with a GIS (e.g. *Mapinfo*) to enable a quick overview of areas of special interest.

The first step is a database rather of single measurements but with links to time-series stored in other software systems related to the data-loggers. Most significant parameters are temperature, air movement, absolute and relative humidity, carbon dioxide, Radon, gamma radiation, microbiology (bacteria & fungi in cave air) as well as aerosol data (chemistry). Other relevant information about the cave is included too. Some 700 datasets of single measurements and several hundred files of time series have been compiled so far.

It is already obvious that a remarkable portion of the Austrian caves would be suitable at least for small scale "speleotherapeutic points" and some of them could be upgraded to larger "speleotherapeutic stations" with no significant interference with the environment.

Unfortunately the public interest in Austria for this extremely cheap and natural treatment - having nothing to do with esoteric irrationalism - is rather poor. A reason for that might be the low financial profile of this method. It could be established easily yielding synergetic effects e.g. for show caves and communities and could be focussed on relatively widespread asthmatic diseases especially of children being treated in medium temperated caves.

EXCURSION

Abb.1: Hydrologische Systeme im südlichen Wiener Becken (aus G. Wessely, "Zur Geologie und Hydrodynamik im südlichen Wiener Becken und seiner Randzone", Mitt. Österr. Geol. Ges. 76, 27-68, Wien 1983)

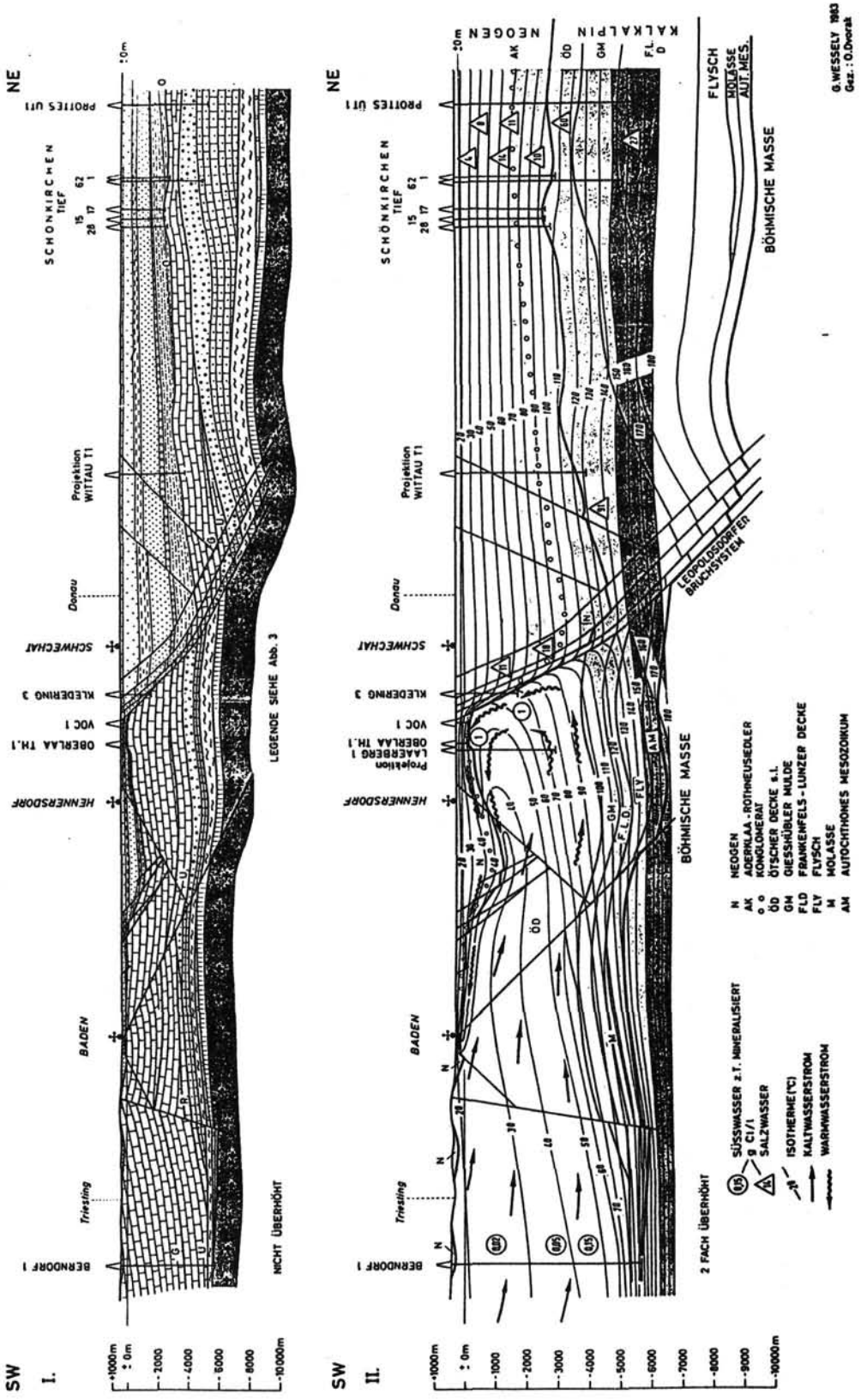

Abb. 2: Schnitt Berndorf-Schönkirchen (I Geologie, II Temperaturverteilung,Hydrodynamik) (aus aus G. Wessely, "Zur Geologie und Hydrodynamik im südlichen Wiener Becken und seiner Randzone", Mitt. Österr. Geol. Ges. 76, 27-68, Wien 1983)

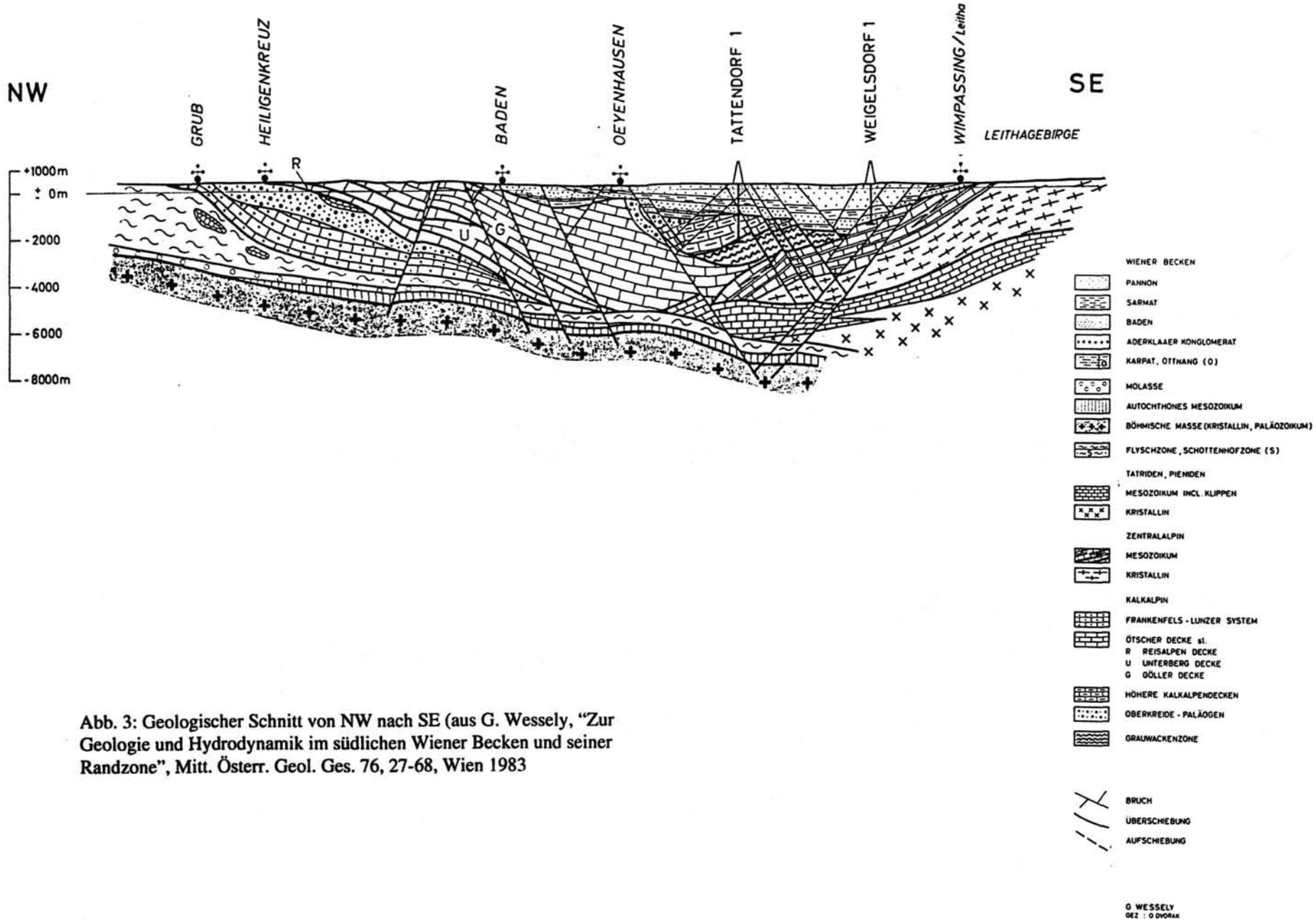

Abb. 3: Geologischer Schnitt von NW nach SE (aus G. Wessely, "Zur Geologie und Hydrodynamik im südlichen Wiener Becken und seiner Randzone", Mitt. Österr. Geol. Ges. 76, 27-68, Wien 1983

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Thomas HOFMANN

Die Badener Thermen in der Überlieferung von Sagen

Einleitung

Die Erklärung geologischer Phänomene und Naturerscheinungen hat erst durch die Etablierung, den Aufschwung und die zunehmende Akzeptanz der Naturwissenschaften im 19. und 20. Jahrhundert breiten Raum gefunden. Vorher war der Erklärung von seltsamen Naturerscheinungen - hier sind Felsformationen ebenso zu nennen, wie breite Sümpfe, warme Quellen oder tückische Flüsse – in der Volkstradition in Form der Sage gegeben, die sich durch mündliches Weitererzählen bis in unsere Tage erhalten hat. In der Sagen sind Antworten und Erklärungsversuche zu finden, die wahre Natur der Dinge zu erklären.

Daraus ergibt sich auch schon im 19. Jahrhundert eine klare Definition von Sage, die sich klar vom Märchen unterscheidet:

*„**Sage**, im allgemeinen alles, was gesagt und von Mund zu Mund weiter erzählt wird, also soviel wie Gerücht; im engeren Sinne eine vom Volke mündlich fortgepflanzte Erzählung von irgendeiner Begebenheit. Knüpft sich die S. an geschichtliche Personen und Handlungen, indem sie die im Volke fortlebenden Erinnerungen an geschichtliche Zustände, Persönlichkeiten, dunkel gewordene Thaten zu vollständigen Erzählungen ausbildet, so entsteht die g e s c h i c h t l i c h e S. und, sofern sie sich auf die alten Helden des Volkes erstreckt, die H e l d e n s a g e; sind aber die Götter mit ihren Zuständen, Handlungen und Erlebnissen Gegenstand der S., so entsteht die G ö t t e r s a g e oder der M y t h u s (s. Mythologie) und auf dem Gebiet monotheistischer dogmatischer Religion, die L e g e n d e (s.d.). Haftet die Erzählung an bestimmten Örtlichkeiten, so spricht man von ö r t l i c h e n S a g e n. Noch eine Sagengattung bildet endlich die Tiersage, welche von dem Leben und Treiben der Tiere und zwar fast ausschließlich der ungezähmten, berichtet, die man sich mit Sprache und Denkkraft ausgerüstet vorstellt.*

....

Die echte S. erscheint somit als aus dem Drang des dichterischen Volksgeistes entsprungen. Obwohl wie alle Volkspoesie am prächtigsten blühend in der ältern Zeit, verstummt sie doch auch bei höherer Kultur nicht; vielmehr ist der Volksgeist noch heute thätig, bedeutende Vorgänge und Persönlichkeiten mit dem Schmuck der S. zu umkleiden. Die Anknüpfung an ein gewisses Wirkliches ist hauptsächlich das Merkmal, welches die S. vom Märchen (s.d.) unterscheidet. Wie das Märchen, liebt sie das Wunderbare und Übernatürliche , obschon ihr dasselbe nicht unentbehrlich ist. Am meisten wohnt sie in Burg- und Klosterruinen, an Quellen, Seen, in Klüften, an Kreuzwegen, ec. und zwar findet sich eine und dieselbe S. nicht selten an mehren Orten wieder.....(„Meyers Konversationslexikon“, 1897)

Deutlich soll hier auf den Passus ...“ *Die Anknüpfung an ein gewisses Wirkliches* ... “ hingewiesen werden. Hier mag auch aus naturwissenschaftlicher Sicht ein Zugang zum Naturverständnis zu suchen sein.

Der Badener Sagenschatz

Im konkreten soll am Beispiel der Kurstadt Baden gezeigt werden, wie vielfältig die Überlieferung sein kann. Ein Zusammenfassung lieferte in jüngster Zeit MAURER (1997), der für den Großraum Baden alle Sagen zusammentrug und im Anhang auch den historischen Aspekt zusammentrug.

Als Quellen wurden hier die Sagen von CALLIANO (1924) herangezogen, zu betonen ist auch schon die Darstellung von RESSEL (1851), der um die Mitte des 19. Jahrhunderts eine später immer wieder tradierte Form festhält. Damit zählt RESSEL zu den ersten, die sich auf Sagen berufen. Generell beginnt erst mit der zweiten Hälfte des 19. Jahrhunderts ein Bewußtsein, daß zur Aufzeichnung von Sagen führt (z. B.: VERNALEKEN, 1859). Wesentliche Impulse lieferte dann LEEB (1892), der ein umfangreiches Kompendium von Niederösterreichischen Sagen zusammengestellt hat. Auf diese greift dann CALLIANO (1924) zurück und gibt dort die Sagen von LEEB im Originalwortlaut wieder.

Auffallend bei den Sagen ist, daß der Geruch von Schwefel, immer wieder mit dem Teufel, der diesmal in verschiedenen Gestalten erscheint, in Verbindung gebracht wird. Das Auftreten eines Priesters, der schließlich den Teufel vertreibt, wie sie CALLIANO (1924) wiedergibt, gibt dem ganzen ein positives Ende. Damit findet sich eine Weiterführung des uralten Dualismus „Gut" und „Böse", der bereits in der Bibel an mehreren Stellen zu finden ist.

Der Teufel in Baden

Der erste Bewohner Badens war der Teufel, der mit Pech und Schwefel in Baden zum ersten Male auf die Erde kam. Da sich vor ihm alles verkroch, nahm er die Gestalt eines Jünglings, eines Mannes und eines Greises an und lockte die Leute in sein stinkendes Schwefelnest, wo sie ihm alle untertänig waren. Dies geschah so lange, bis ein Priester aus dem fernem Lande mit dem heiligen Kreuze ihn für ewig in die Hölle bannte.

Thematisch paßt hier eine andere - ebenfalls von CALLIANO (1924) überlieferte - Sage her, die einen Menschen thematisiert, der schon lange bei den Thermen wohnt und folglich als „Schwefelmann" bezeichnet wird. Als realer Konnex kann hier durchaus ein Zusammenhang mit einem möglichen Einsiedler gegeben sein, der im allgemeinen menschliche Gesellschaft scheute.

Der Schwefelmann zu Baden

Im Herzogsgarten lebte in alter Zeit ein Mensch, der in der heißen Quelle wohnte und einen Bart hatte, der bis auf die Erde hing und so gelb wie der Schwefel war. War niemand im Herzogsgarten, so kam er aus der Quelle heraus und ging im Garten spazieren.
Niemand tat ihm, aber auch er tat niemanden etwas zu Leide. Da war einmal eine stürmische Nacht und das Wasser wurde rot wie Blut; am Morgen fand man den Schwefelmann tot in der Quelle.

Weniger dramatisch, beinahe biedermeierlich romantisch ist die Überlieferung von Anton MAILLY (1926), der immerhin schon von römischen Thermen spricht, die lange Zeit verschollen waren und erst wieder entdeckt werden mußten.

Die wiederentdeckten Thermen von Baden

1. *Die römischen Thermen von Baden wurden durch die Rüden eines Ritters von Rohr wieder aufgefunden. Ein Chronist berichtet nämlich, daß die aussätzigen Rüden dieses Ritters sich täglich in den Tiefen des Forstes verliefen und nach kurzer Zeit gesund wurden. Da die Rüden stark nach Schwefel rochen, gingen die Knechte den Tieren nach und fanden sie in den dampfenden aufsprudelnden Quellen baben. So wurden die alten Thermen von Baden wiederentdeckt.*

2. *Auf dem Türmchen der abgebrochenen Frauenkirche in Baden sollen die Steinbilder eines Bären, einer Gemse, eines Rehbockes und dreier Hunde angebracht gewesen sein, und zwar zum Andenken, daß die drei Hunde diesen Tieren nachliefen und in die Gegend der vergessenen römischen Thermen gekommen seien, was zur Entdeckung des Heilbades geführt hätte.*

Einen anderen Aspekt finden wir nachfolgend bei RESSEL (1851), wobei zu bemerken ist, daß es sich hier bei der Überlieferung der Sage nicht um eine der klassischen Sagensammlungen handelt, wie wir sie von dem Benediktinermönch Pater Willibald LEEB aus Stift Göttweig oder von CALLIANO kennen, sondern eine spätbiedermeierliche Darstellung in Form einer Topographie vorliegt:

Von dem Wiederauffinden der heilenden Quellen Badens

Die aussätzigen Rüden (Hunde) eines in diesen Gegenden hausenden Ritters", so meldet nämlich diese Sage, "verliefen sich täglich in den Tiefen eines ungeheuren Forstes, welcher damals diese Fluren bedeckte, und kehrten stets in gesünderem Zustande wieder. Man ward hierauf immer aufmerksamer - besonders auf den Schwefelgeruch, welchen die Hunde von sich gaben. Endlich schliechen die Knechte den letzteren nach, und trafen selbe - in der dampfend aufsprudelnden Quelle instinktmäßig badend: und schnell verbreitete sich diese staunenswerthe Mähre. Auch die kranken Menschen hofften Entfernung oder wenigstens Linderung ihrer Leiden von der heilenden Quelle - bedienten sich deshalb derselben, und genasen. Alsbald ward der Forst gelichtet, und zahlreiche Anbaue umgaben immer mehr die gottgesegnete Quelle.

Die eben oben zitierte Version greift CALLIANO (1924) auf und gibt sie fast im selben Wortlaut wieder.Anton MAILLY (1926) teilt in der Reihe *„Eichblatts Deutscher Sagenschatz*, Band 12: *Niederösterreichische Sagen*" unter den „Landesgeschichtlichen Sagen" eine Version mit, wo Kaiser Karl namhaft gemacht wird. Interessant ist hier die Nennung einer Burg, die von „warmen und kalten Bächlein (Gräben)" umgeben ist:

Kaiser Karl in Rohr bei Baden

In Rohr bei Baden gibt es einen Platz, wo einst eine Burg gestanden, von der die alten Leute erzählen, daß sie von warmen und kalten Bächlein (Gräben) umschlungen war. Dort war ein großer Baum, an dem sich ein Bild befand, das des Kaisers Schild war und das der Kaiser bei einem großen Kriege, nachdem er die Feinde beim Schildbach geschlagen, dort als stetes Erinnerungszeichen aufhängen ließ.

Wer nun wirklich das heilsame Schwefelwasser entdeckte, wird wohl nie zu ergründen sein. Fest steht, daß es nicht der Teufel war. Wenn es wirklich Hunde gewesen sein sollen, dann mit Sicherheit nicht die des Herzogs von Rohr, sondern wohl eher römische Hunde. Den Beweis dafür liefern Ziegel mit den Aufschriften LEGXGPF (Legio Decima gemina pia fidelis) und LEGXIIIIGMV (Legio decima quarta gemina martia victrix), die "bei der am Fuße des Calvarienberges entspringenden Quelle" im Jahre 1796 gefunden wurden. Aus der Feder Marc Aurels sind "*aquae pannoniae*" und "*thermae cetiae*", überliefert, ob er selbst hier weilte, ist nicht zu beweisen, aber auch nicht auszuschließen. Immerhin wird heute noch eine Quelle als "Römerquelle", oder Ursprungsquelle bezeichnet, mit einer Schüttung von zwei Litern pro Sekunde zählt sie zu den ergiebigsten der insgesamt 14 Quellen.

Wohl ging dann das Wissen um die Heilkraft der Quellen in den Wirren des ersten Jahrtausends verloren. Urkundlich wird Baden im Jahre 1073 in einer Melker Urkunde erstmals erwähnt, als Popo von Rohr Zeugenschaft gibt. Hier könnte auch eine Verbindung zur Wiederauffindung der Quellen bestehen, denn andere Chronisten sprechen von den "*aussätzigen Rüden eines Ritters von Rohr.*"

Abschließend sei noch auf eine - ebenfalls von CALLIANO 1924 tradierte - Sage hingewiesen, wo von einem „Häferl voll Glut" die Rede ist. Auch wenn hier nicht von Thermalwasser oder Quellen die Rede ist, legt die Glut einen gewisse Nähe zur Thermenproblematik nahe:

Das Gluttöpfchen in Rohr

Ein armes, altes, zahnloses Weiblein kam einst nach Rohr und sah dort eine reiche Badenerin in der Au am Arme eines Mannes lustwandeln. Das arme Weiblein, das sich vor lauter Hunger kaum mehr aufrecht erhalten konnte, bettelte das vornehme Paar schüchtern um Brot an und die Badenerin stieß eine Brotkrumme, die gerade am Wege vor ihr lag, mit dem Fuße von dannen und schrie: „Hier liegt Brot, gut genug für ein Scheusal Deiner Art" und spuckte vor sich hin. Das arme Weib nahm die „Gottesgabe" und schlich sich weinend, ohne Klage von dannen und kam bald, noch die trockene Rinde kauend, zu einer Sandfläche, in welcher ein „Häferl voll Glut" eingegraben war. Und als das Weiblein erstaunt über diesen Fund sich zur Erde neigte, fielen einige Brotbrösel in die Glut und diese verwandelte sich sofort in pures Gold. Von da ab hatte die Not und der Hungerdes alten Weibes ein Ende.

Ausblick

Diese kurze Darstellung der thematischen Vielfalt soll eine Aufforderung sein, die mündliche Tradition der Sagen, die erst ab dem 19. Jahrhundert schriftlich niedergelegt wurde, durchaus auch bei naturwissenschaftlichen Betrachtungen zu berücksichtigen. Wohl sind hier keine Erklärungen zu erwarten, die dem Naturwissenschaftler des 21. Jahrhunderts genügen werden, aber es zeigt durchaus das ernste Bemühen vergangener Generationen Naturphänomene aus der damaligen Sicht unter Berücksichtigung der engen, durch die Religion vorgegebenen Rahmenbedingungen zu erklären.

In Sagen zeigt sich in vielen Fällen eine sehr genaue Naturbeobachtung, lediglich die Erklärung der Phänomene mag heute nicht mehr zeitgemäß erscheinen, dennoch ist das Studium von Sagen nicht nur für den Volkskundler, sondern auch für den Naturwissenschaftler (HOFMANN, 2000) ein ernst zunehmender, nicht zu vernachlässigender Aspekt im Zuge des umfassenden Quellenstudiums beim Bemühen nach einer umfassenden Darstellung.

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Heinz KRENN

Bericht zur Führung durch die Schwefelwasserquellen anlässlich der Tagung der Geologischen Bundesanstalt am 17. November 1999

Gesamtsituation

Im inneren Stadtgebiet von Baden entspringen 14 natürliche Quellen. Die meisten bedingt durch die geologische Situation (Schwechatbruch) im Bereiche des Schwechatbaches. Beginnend vom Sauerhof in welchem die Sauerhofquelle entspringt, des Engelsbades mit der Engelsbadquelle weiter auf der anderen Seite der Schwechat die Johannes- und Ferdinandsquelle, zur Franzensquelle und dann weiter in Richtung Josefsplatz zu der im Bachbette der Schwechat liegenden Marienquelle.

Marienquelle

Die Marienquelle (benannt nach der Frau des damaligen Bürgermeisters Kollmann) in der Braitnerstraße 3 wurde im Bachbette angeblich von spielenden Kindern entdeckt. Am 17. Mai 1924 wurde mit den Fassungsarbeiten der Quelle begonnen. Man fand bereits im Bachschotter eine durch das aufsteigende Schwefelwasser gebildete Thermalschale, welcher man folgte. Man trieb hölzerne Spundwände in den Bachschotter, welche einen rechteckigen Kasten bildeten. Innerhalb dieses Kastens wurde der Thermalschale nachgegangen. Die Fassungsarbeiten wurden aber nicht bis zum Felsen vorgetrieben, da in dieser Zeit mehrere Quellen in Privatbesitz waren und der Betrieb der damit verbundenen Bäder auf den natürlichen Druck der Quellen angewiesen war. Durch die zeitweise sehr hohen abgepumpten Mengen im Zuge der Fassungsarbeiten fiel der Quelldruck und die Schüttungsmengen derart, daß ein Füllen der Badebecken und ein Überlauf nicht mehr möglich war. Um Rechtsfolgen zu vermeiden, wurden von der Stadtgemeinde Baden die Johannes- und Ferdinandsbäder gekauft und die Fassungsarbeiten in den Bachschotter schnell vorangetrieben und vor Erreichen der Tegelschicht (ca 0,8-1 m oberhalb; 4,8 m unter Normalwasserspiegel der Schwechat) innerhalb von 90 Tagen abgeschlossen. Die nach den Fassungsarbeiten durch natürlichen Druck austretende Wassermenge betrug ca. 50 l/s. Da durch diese hohe Wassermenge die anderen Quellen eine zu geringe Schüttung aufwiesen, mußte das Steigrohr der Marienquelle am 10. August auf eine Seehöhe von 227,162 m erhöht werden, worauf die Schüttungsmenge auf 45,83 l/s fiel. Am 25. Februar 1925 mußte Auslaufhöhe weiter auf 227,892 m erhöht werden, worauf die Schüttung auf 40,71 l/s zurückging. Bereits am 2. August 1925 wurde diese überhastet gebaute Quellfassung durch ein Erdbeben (Epizentrum im Semmeringgebiet) undicht und die Schüttung der Quelle sank auf 8,64 l/s. Die Quellfassung wurde durch Betoninjektionen in den umgebenden Schotter abgedichtet. Die Schüttung wurde dadurch und durch Entfernen des Aufsatzes am Steigrohr (227,162 m) wieder auf die vorherige Schüttung von ca. 46 l/s gebracht. Um das Schwefelwasser der Marienquelle zu nutzen, wurde im Jahre 1926 in nur 90 Werktagen Bauzeit das Thermalstrandbad gebaut, welches von der Marienquelle mit einer Bleileitung (NW 250) versorgt wurde. Im Laufe der Jahre wurde aber die Quelle zunehmend undicht. Im Jahre 1964 war die Schüttung auf ca. 5 l/s gesunken und ein Betrieb des Thermalstrandbades dadurch fast unmöglich geworden. Die Stadtgemeinde Baden war dadurch zu einer Neufassung, welche in den Jahren 1965 durchgeführt wurde, gezwungen. Da in der Zwischenzeit fast alle Quellen (ausgenommen der Engelsbadquelle und Mariazellerquelle) im Besitz der Stadtgemeinde Baden waren, konnten die Fassungsarbeiten bis zum Felsen vorgetrieben werden und es wurde sogar dem Wasser über einen kurzen Stollen im Felsen nachgegangen. Auf den Felsen wurde direkt die Quellkammer aufgesetzt, von welcher ein Steigrohr aus PVC mit einer GFK Ummantelung

zum Überlaufbecken führt. Die Überlaufhöhe HGeod = 227,16 m. Nach den Fassungsarbeiten betrug die Schüttung 68 l/s, welche aber bis 1971 auf 50 l/s und in den folgenden Jahren weiter absank. So sank die Schüttung der Marienquelle während der Fassungsarbeiten im Jahre 1974 an der Leopoldsquelle kurzzeitig auf 34 l/s um dann im Jahre 1975 wieder auf 39,5 l/s anzusteigen. Die Schüttung sank dann weiter bis ins Jahr 1983 auf 30 l/s und 1985 auf 28 l/s. Die dezeitige Schüttung der Marienquelle beträgt ca. 21 l/s. Vom Überlaufbecken der Marienquelle wird das Schwefelwasser über eine Rohrleitung in einen Pufferbehälter in den danebenliegenden Maschinenraum geleitet. Von dort wird das Schwefelwasser mittels Pumpen über mehrere Kunsttoffrohrleitungen (GFK) in das Thermalstrandbad, in die Sonderheilanstalt der Wiener Gebietskrankenkasse und in das Kurhaus geleitet.

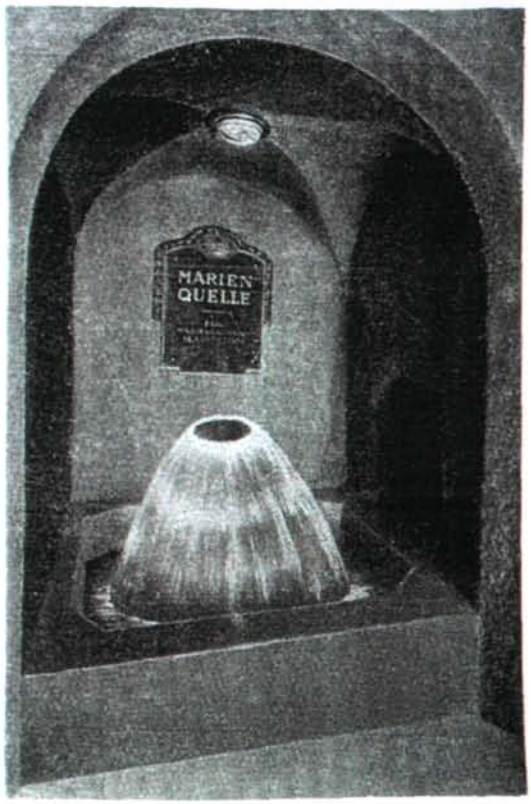


Abb.1: Marienquelle (Archiv: H. Krenn)

Abb. 2: Marienquelle – Austritt in die Schwechat (Schwechat heißt übersetzt „Stinkender Fluss" (Anm. der Herausgeber)) (Aufnahme: G. Hobiger)

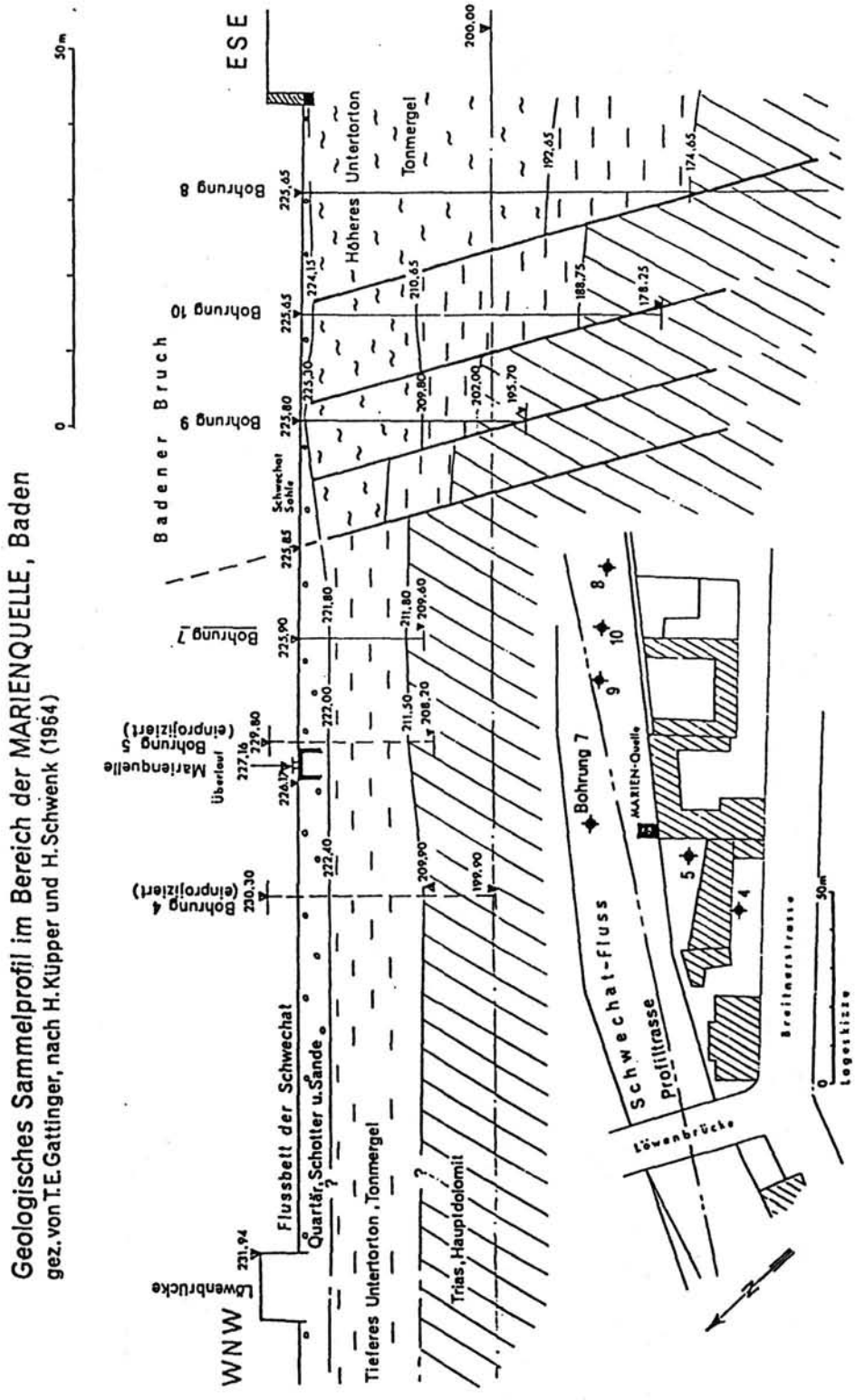


Abb. 3: Geologisches Profil Marienquelle

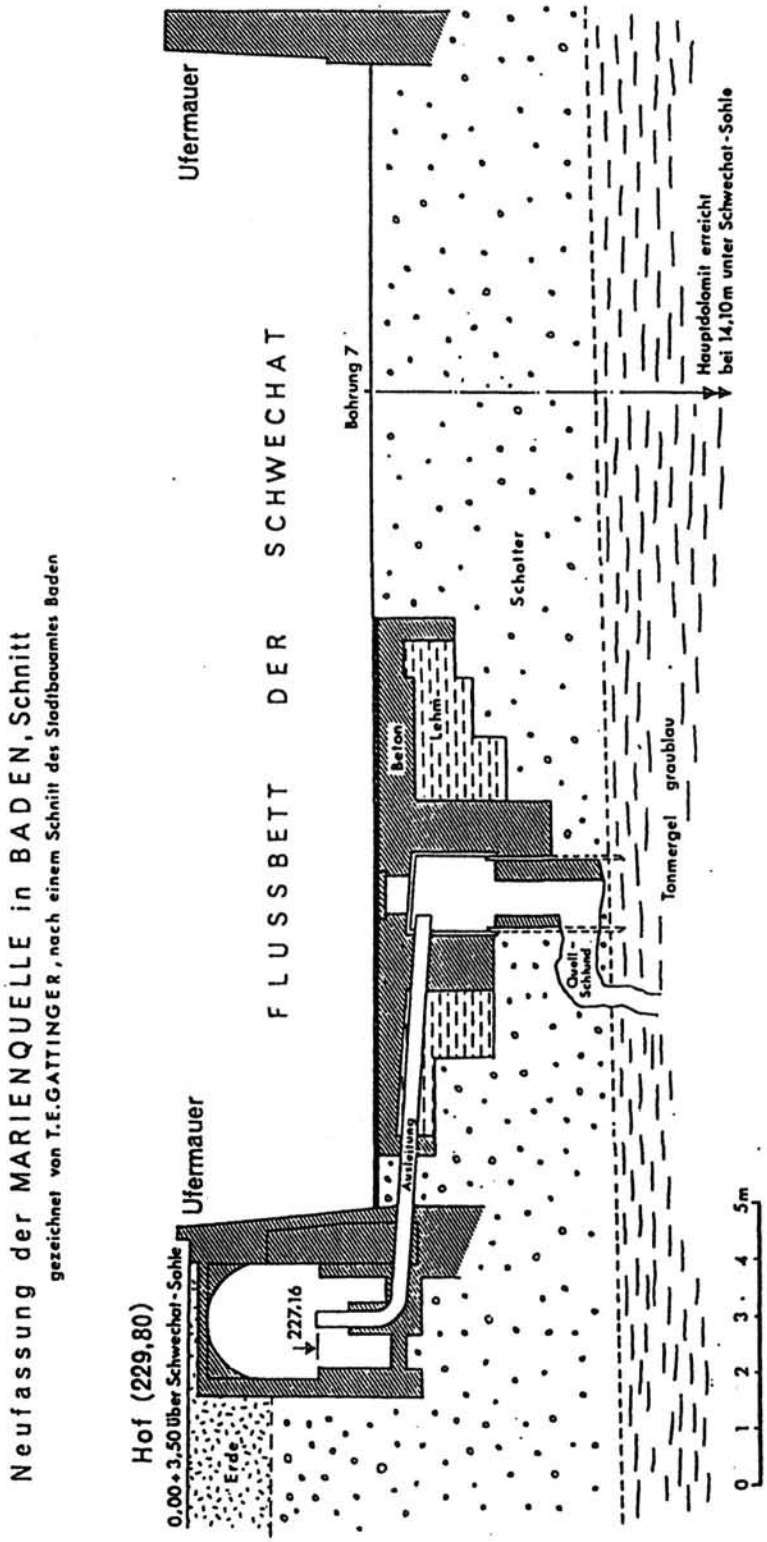


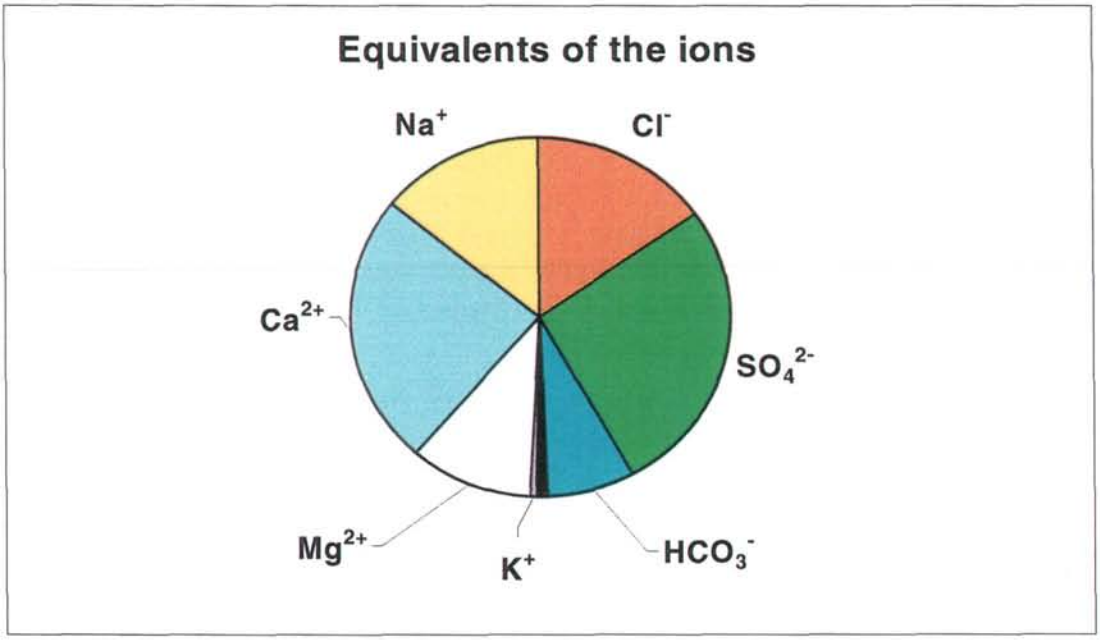
Abb. 4: Neufassung der Marienquelle

Chemistry of the Marienquelle (analysed by „ Bundestaatliche Anstalt für experimentell pharmakologische und balneologische Untersuchungen „ in Vienna)

Discharge (l/s)	52,5
Density (g/cm³) (20°C)	0,9999
Temperature (°C)	35,3
Contuctivity (µS/cm) (20°C)	2210
pH	6,8

Kations			
Ion	mg/kg	meq/kg	eq%
Ca^{2+}	271,7	13,56	48,94
Na^{+}	181,5	7,895	28,49
Mg^{2+}	71,0	5,84	21,09
K^{+}	9,1	0,233	0,84
Sr^{2+}	4,75	0,1084	0,39
NH_4^{+}	0,32	0,0177	0,06
Li^{+}	0,3	0,0432	0,16
Al^{3+}	0,07	0,0078	0,03
Ba^{2+}	0,024	0,00035	0,0013
Fe^{2+}	0,020	0,0007	0,0026
Σ Kations	538,784	27,7068	100,0

Anions			
Ion	mg/lkg	meq/kg	eq%
SO_4^{2-}	711,2	14,807	53,34
Cl^{-}	301,0	8,49	30,59
HCO_3^{-}	253,1	4,15	14,94
HS^{-}	5,6	0,169	0,61
F^{-}	2,5	0,1316	0,47
$S_2O_3^{2-}$	0,6	0,0107	0,04
Br^{-}	0,26	0,0033	0,01
NO_3^{-}	0,06	0,00097	0,003
I^{-}	0,045	0,00035	0,001
$HAsO_4^{2-}$	0,017	0,00024	0,001
HPO_4^{2-}	0,02	0,00042	0,002
Σ Anions	1274,1	27,75810	100,0



Unionzied Components			
Component	mg/kg	mmol/kg	cm³ *
H_2SiO_3	27,50	0,352	-
HBO_2	2,2	0,050	-
CO_2	44	1,000	22,2
H_2S	9,1	0,267	5,91

* ... at 0 °C, 760 Torr

Radioaktive Elements		
Element	Unit	
Uranium	mg/kg	3,20E-04
Radium	mg/kg	7,60E-09
Radon	Curie/kg	1,30E-09

Total mineralisation (mg/kg)	1843

Römer- oder Ursprungsquelle in der Arenastraße

Zur Römerzeit war Baden ein Badeort der römischen Legionssoldaten. Kaiser Marcus Aurelius Antonius spricht in seinen Schriften von den pannonischen Wässern (Aquae pannonicae), den cethischen Bädern (thermae cetiae) auf der Straße von Vindobona (Wien) über Aquis (Wässer oder Bäder) und Scarabantia (Oedenburg) nach Sabaria (Stein am Anger), womit offensichtlich die Badener Schwefelquellen gemeint waren. Mauerreste eines römischen Dunstbades mit Ziegel der X. und XIV. Legion, wurden beim Bau des Ursprungsbades, der Sommerarena und beim Baue der Trinkhalle östlich der Ursprungsquelle gefunden. Einige dieser Ziegelsteine sind in der Eingangshalle der Römerquelle zu sehen. Die Römerquelle entspringt aus einer Felsspalte des Kalvarienberges, welche schon in früher Zeit mit einem Steingewölbe überdeckt wurde. Als im Jahre 1767 (laut Carl Schenk 1764) das niedere Felsgewölbe der Quellkammer, zersetzt von den Dünsten der Quelle, einzustürzen drohte und abgetragen werden mußte, fand man in einer der Wände einen viereckigen Stein (Dr. Karl Szuberka - Die Schwefelthermen zu Baden bei Wien, Eigenverlag der Bäderdirektion 1882) auf welchen nach Aussage glaubwürdiger Zeugen unter anderem das Wort „Aquae" lesbar war, was bei den Römern ein öffentliches Bad bedeutete. Dieser Stein war aber von den Dämpfen so zermürbt, daß er bei der Bergung zerfiel. Das Gewölbe wurde anschließend als höheres Steingewölbe neu erbaut und gleichzeitig ein größere rechteckige Quellfassung aus Stein hergestellt. Im Jahre 1796 stieß man beim Bau des Ursprungsbades auf die Reste eines römisches Dunstbads.

Im Jahr 1716 wurde die Stadt Baden Eigentümerin der Ursprungsquelle durch den Ankauf der Herzogs- und Antonsbäder vom Grafen Lamberg. Die Schüttung der Römerquelle wird in alten Unterlagen mit über 20 l/s angegeben. Im Jahre 1925 wir diese mit 8 l/s (Die Schwefelthermen Bäder und Kuranstalten der Kurstadt Baden bei Wien herausgegeben vom Verein der Niederösterreichischen Landesfreunde 1925) angegeben. Im Jahre 1999 betrug die Schüttung der Römerquelle ca 2,6 l/s. Durch den Pumpversuch in der am Josefsplatz niedergebrachten Schwefelwasserbohrung "Josefsquelle 1" mit einer Pumpleistung zwischen 20 und 25 l/s ist die Schüttung der Römerquelle auf einen Wert von knapp 2 l/s zurückgegangen.Vom Quellschacht der Römerquelle (Überlaufkante auf 237,389 m) wurde das Wasser über die unter dem Fußboden des Ganges zur Quellkuppel befindlichen Rohrleitungen (ursprünglich aus Holz, später aus Blei und jetzt aus GFK) zu einem unter dem derzeitigen Casinorestaurant gelegenen Behälter und von dort zu den Badebecken des Herzogs-Antons und Theresienbades geleitet. Beim Umbau des Kongreßhauses zum heutigen Congress Casino im Jahre 1993 wurde dieser Pufferbehälter mitsamt der Pumpstation zum Eingang des Kurparkes ausgelagert. Die Zuleitung zu diesem Behälter ist im Gefälle verlegt (Freispiegelleitung). Die Speicherkapazität des neuen Behälters beträgt 180 m³. Von diesem Behälter werden derzeit die Sonderheilanstalt der Bauern in der Renngasse und die Sonderheilanstalt der Selbsständigenkrankenkasse in der Malchergasse beliefert.

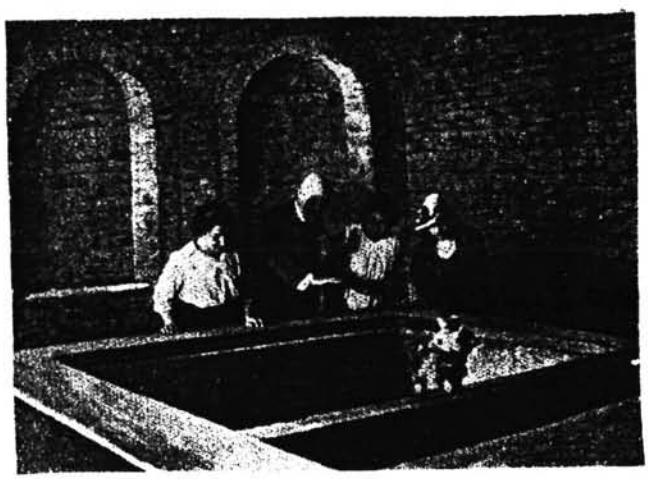


Abb. 5: Römerbad (Archiv: H.Krenn)

Abb. 6: Neufassung der Römerquelle (Aufnahme: G. Hobiger)

Abb.: 7.: Gedenkdafel bei der Neufassung der Römerbadquelle (Aufnahme: G.Hobiger)

PARTICIPANTS

Fig.1: Seminar of W. Kollmann (Picture: G. Hobiger)

Fig. 2: Participant B. Bølviken by the Seminar (Picture: G. Hobiger)

Fig.3: Participants by the Seminar (Picture: G. Hobiger)

Dr. Katalin AUGUSTIN-GYURITS
Arsenal Research
Faradaygasse 3
A-1030 Wien
Austria
Phone: +43 (1) 79747-0
e-mail: Augustin-Gyurits.K@arsenal.ac.at

Prof. Dr. Esref BECIROVIC
Department for physical medicine and rehabilitation
Jzu.Dom Zdrvya, Ul. A. Heryevica Br. 1
BH-7500 Tuzla
Bosnia and Hercegovina
Phone: +378 (75) 283063

Univ. Doz. Dr. Lothar BECKEL
Geospace
Jakob-Harringer-Straße 1
A-5020 Salzburg
Austria
Phone: +43-(662)-458115
e-mail: office@geospace.co.at

Mag. Gerhard BIEBER
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: gbieber@cc.geolba.ac.at

Dr. Bøjrn BØLVIKEN
Geolocical Survey of Norway
N-7491 Trondheim
Norway
Phone: +47 73904011
e-mail:bjorn.bolviken@ngu.no

Dr. Iris BUXBAUM
Arsenal Research
Faradaygasse 3
A-1030 Wien
Austria
Phone: +43 (1) 79747-0
e-mail: Buxbaum.I@arsenal.ac.at

Prof. Dr. John DAVIS
Kansas Geological Survey, University of Kansas,
1930 Constant Ave., Lawrence, KS 66047-3726
USA
Phone: 785-864-2101
e-mail:jdavis@kgs.ukans.edu

Dr. Gerhard HEISS
Arsenal Research
Faradaygasse 3
A-1030 Wien
Austria
Phone: +43 (1) 79747-0
e-mail: Heiss.G @arsenal.ac.at

Dr. Gerhard HOBIGER
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: ghobiger@cc.geolba.ac.at

Mag. Thomas HOFMAN
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: thofman@cc.geolba.ac.at

Dr. Robert HOLNSTEINER
Arsenal Research
Faradaygasse 3
A-1030 Wien
Austria
Phone: +43 (1) 79747-0
e-mail: Holnsteiner.R@arsenal.ac.at

Dr. Jurian HOOGEWERFF
Arsenal Research
Faradaygasse 3
A-1030 Wien
Austria
Phone: +43 (1) 79747-0
e-mail: Hoogewerff.J@arsenal.ac.at

HR. Dr. Werner JANOSCHEK
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: wjanoschek@cc.geolba.ac.at

HR Dr. Peter KLEIN
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: pklein@cc.geolba.ac.at

HR Dr. Walter F. H. KOLLMANN
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: wkollmann@cc.geolba.ac.at

Mag. Christian KRASSNIG
Büro f. Int. Forschungs- und
Technologiekooperation (BIT)
Wiedner Hauptstraße 76
A-1040 Wien
Austria
Phone: +43 (1) 58116 16 – 142
e-mail: krassnig@bit.ac.at

Dr. Pavol LUCIVJANSKY
Geological Survey of Slovak Republic
Geoanalytical Laboratories
SK- 05240 Spisska Nova ves
Slovak Republic
e-mail: luciv@gsrcsn.sk

Dr. Karl MAIS
Naturhistorisches Museum Wien, Abt. für Karst und Höhlen
Museumsplatz 1-10
A-1010 Wien
Austria
Phone:+43 (1) 523 04 18
e-mail: SPELEO.AUSTRIA@NETWAY.AT

HR Dr. Gerhard MALECKI
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: gmalecki@cc.geolba.ac.at

Univ. Prof. Dr. Wolfgang MARKTL
Inst. f. Umweltphysiologie
Schwarzspanierstraße 17
A-1090 Wien
Austria
Phone: +43 (1) 4277 62110

Dr. Friedrich W. MARSCH
Hydroalpina
Oberlungitz 67
A-8230 Hartberg
Krottenbachstraße 9
A-1190 Wien
Austria
Phone: +43 (3332) 61575
e-mail: HYDROALPINA@aon.at

Univ. Prof. Dr. Sepp PORTA
Inst. f. Angewandte Stressforschung
Hauptplatz 2-4
A-8490 Bad Radkersburg
Institut f. Allgemeine und experimentelle Pathologie
Universität Graz
Austria
e-mail: stresscenter@netway.at

Univ. Doz. HR Dr. Manfred SAGER
Bundesamt und Forschungszentrum für Landwirtschaft
Spargelfeldstrasse 191
A-1226 Vienna P.O. BOX 400
Austria
Phone: +43 (1) 73216-0
e-mail: manfred.sager@relay.bfl.at

Dr. Robert SAJN
Geological Survey of Slovenia
Dimiceva 14,
SI-1000 Ljubljana
Slovenia

Dr. Joseph SAMAN
Water Authority Amman
P.O.Box: 2412
11121 Amman
Jordan
e-mail: ammpprj@rja.com.jo

HR DDr. Diets SAUER
Arsenal Research
Faradaygasse 3
A-1030 Wien
Austria
Phone: +43 (1) 79747-0

Dr. Albert SCHEDL
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: aschedl@cc.geolba.ac.at

Dr. Othmar SCHERMANN
Neusiedlerstraße 17
A-7092 Winden
Austria
Phone: +43 (2160) 8678

Dir. Univ. Prof. HR Dr. Hans P. SCHÖNLAUB
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: schhp@cc.geolba.ac.at

Dr. Gerhard SCHUBERT
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: gschubert@cc.geolba.ac.at

DI Siavaush SHADLAU
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: sshadlau@cc.geolba.ac.at

Mag. Barbara TRÄXLER
Geologische Bundesanstalt
Rasumofskygasse 23
A-1031 Wien
Austria
Phone: +43 (1) 712 56 74-0
e-mail: btrexler@cc.geolba.ac.at