Dipartimento Tutela Ambientale - Protezione Civile
Servizio Bonifica dei Siti Inquinati e Geologia Ambientale
ROMA CAPITALE

REVIEW ON AVAILABLE DATA ABOUT NATURAL BACKGROUND LEVELS OF DISSOLVED ELEMENTS IN THE GROUNDWATER OF ROME (ITALY)

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Natural background levels (NBL) of groundwater, are defined as the concentration of a given element, species or chemical substance present in solution of a groundwater body which is derived by natural processes from geological, biological or atmospheric sources. Substances need to be understood in the context of their geochemical setting. This may often be difficult where substances exhibit high NBL in relation to any presumed anthropogenic component (Hart and Müller, 2006).

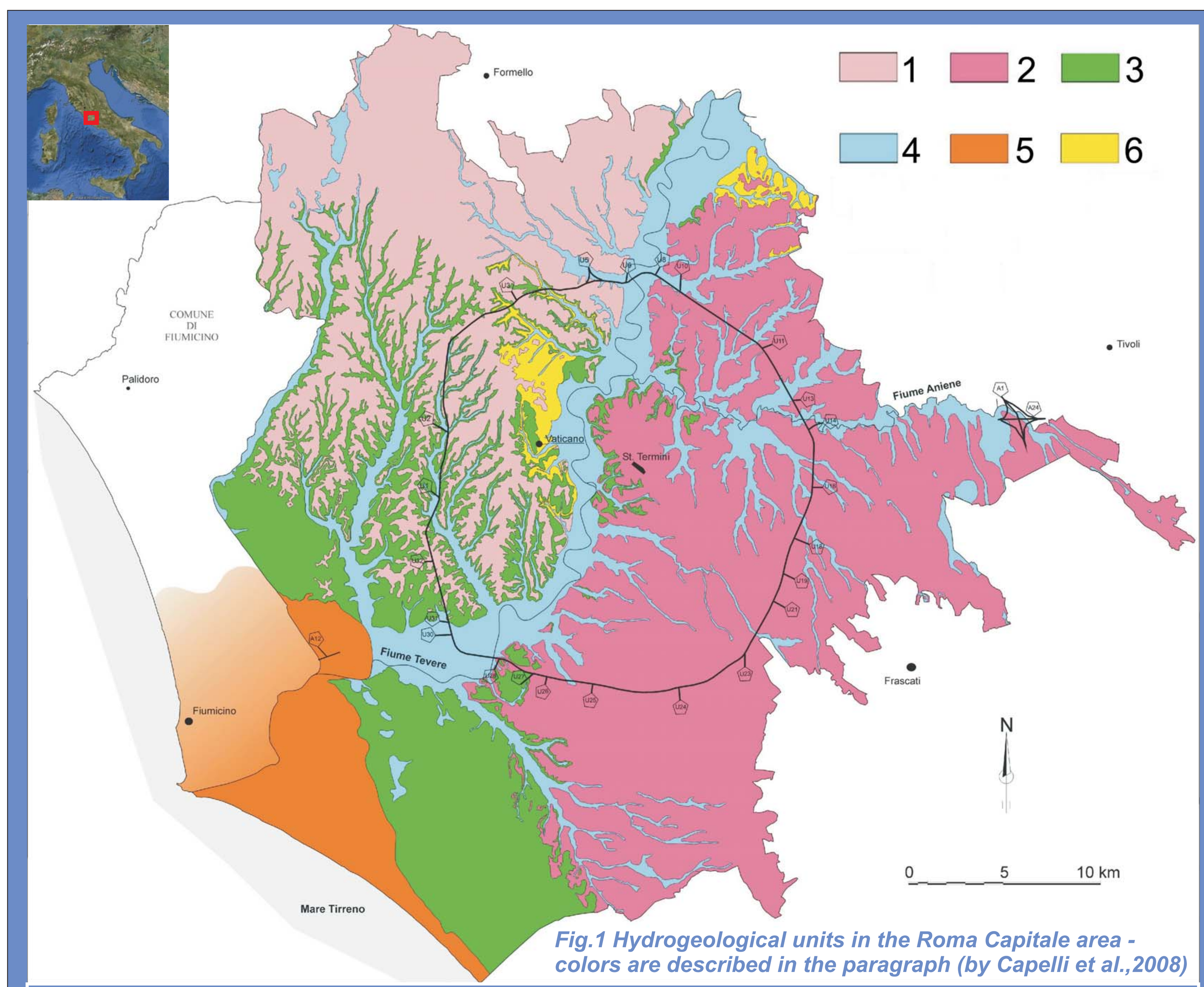

Fig.1 Hydrogeological units in the Roma Capitale area - colors are described in the paragraph (by Capelli et al.,2008)

Main references on the hydrogeology of Rome:

Capelli G., Mazza R., Taviani S. (2008) Acque sotterranee nella città di Roma, in Memore descrittive della Carta Geologica d'Italia Vol. 80 - La geologia di Roma dal centro storico alla periferia

Corazza A., Lombardi L. (1995) Idrogeologia dell'area del centro storico di Roma, in Memore descrittive della Carta Geologica d'Italia Vol. 50 - La geologia di Roma: il centro storico

Di Salvo C. , Moscatelli M., Mazza R., Capelli G., Cavinato G.P. (2014) Evaluating groundwater resource of an urban alluvial area through the development of a numerical model, Environmental Earth Sciences, DOI 10.1007/s12665-014-3138-4

La Vigna F., Capelli G., Mazza R. (2008) Assetto idrogeologico del settore romano del bacino del Fiume Aniene, in Memore descrittive della Carta Geologica d'Italia Vol. 80 - La geologia di Roma dal centro storico alla periferia

La Vigna F., Ciadamidaro S., Mazza R., Mancini L. (2010) Water quality and relationship between superficial and groundwater in Rome (Aniene River basin, central Italy), Environmental Earth Sciences, DOI 10.1007/s12665-009-0267-2

La Vigna F., Demiray Z., Mazza R. (2013) Exploring the use of alternative groundwater models to understand the hydrogeological flow processes in an alluvial context (Tiber River, Rome, Italy), Environmental Earth Sciences, DOI 10.1007/s12665-013-2515-8

Hydrogeological setting of ROME

The area of Roma Capitale (Municipality of Rome) has a particular geological and hydrogeological setting. It is in fact strongly influenced by the coexistence of tectonic activity, volcanism of several volcanoes (the Vulsini, Cimini, Sabatini volcanic complex northward, the Colli Albani volcanic complex to the south) and eustasy. By a general hydrogeological point of view, the roman area is placed between three regional structures and the aquiclude of the Pliocene Clays (which can be considered the bedrock of this area, with more than 800 meters of thickness).

Going into details, main aquifers of Rome are located in the Colli Albani volcanic pozzolanaceous products and in the continental and alluvial prevolcanic and sinvolcanic sediments. Moreover Olocene valleys, filled by postvolcanic alluvial sediments, are interested by a confined aquifer into the gravels placed in the base of the alluvial sequence (Capelli e al. 2008).

Thus there are 6 HYDROGEOLOGICAL UNITS that can be indentified and are shown in Fig.1:

- 1) THE VOLCANIC AQUIFERS OF SABATINI VOLCANO
- 2) THE VOLCANIC AQUIFERS OF COLLI ALBANI VOLCANO
- 3) THE CONTINENTAL AQUIFERS OF PALEO-TIBER AND PONTE GALERIA FORMATION
- 4) THE ALLUVIAL AQUIFERS OF THE TIBER BASIN
- 5) THE TIBER FAN
- 6) THE AQUICLUDE OF M. VATICANO CLAYEY PLIOCENE FORMATION

Looking at hydraulic relationships between these units, the main groundwater circulations which can be identified are: the basal Tiber alluvial gravel body, the volcanic and prevolcanic aquifer's body in the orographic left of Tiber, the volcanic and prevolcanic aquifer's body in the orographic right of Tiber, and the alluvial fan aquifer's body.

Due to the particular geological and hydrogeological setting, described above, the presence of many natural elements (i.e. As, F, V, Mn, Fe) and compounds dissolved in groundwater is widely documented, sometimes and somewhere exceeding the law thresholds, due to the volcanic and mineral nature of soils and hydrothermal activity. At the same time is important to consider that some elements, naturally contained in soils, may be also mobilized by pollution phenomena, by changing in physical and chemical conditions (Temperature, pH, etc.) so their concentrations in groundwater may have also significant, local, not natural increase. Anyway background levels in groundwater are the result of water–rock interaction, chemical and biological processes both in the vadose and saturated zone, relationships with other water bodies, atmosphere and rainfall composition. For this reason, spatial variablity of background level of a substance present in solution in a specific groundwater body can be huge and a single value may be difficult to define (Preziosi et al. 2010).

Dissolved elements or compounds that are founded in groundwater derive from the presence of typical minerals, formed during volcanic and metamorphic activities. Relationships between elements/compounds and minerals are shown in Fig. 2

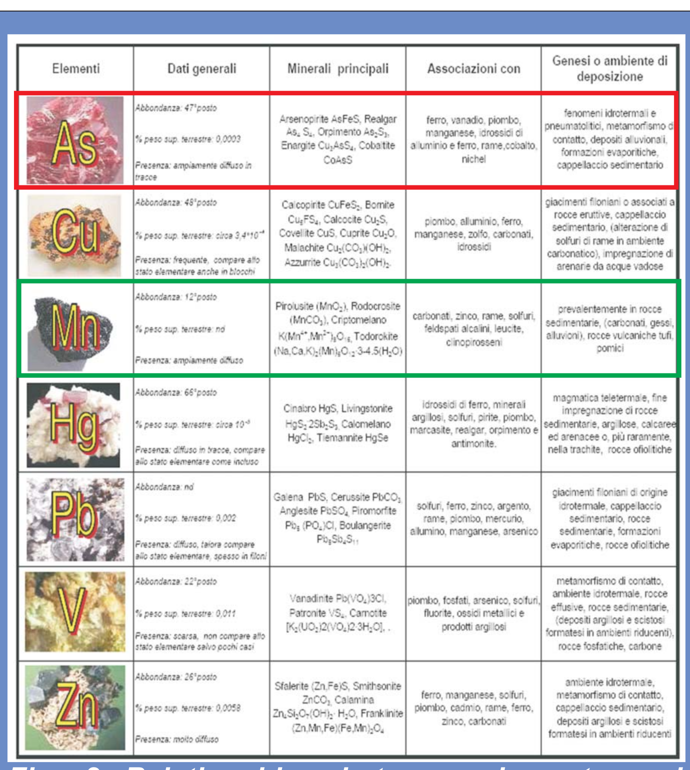

Fig. 2 Relationships between elements and minerals (by Pirani and Vecchio, 2009)

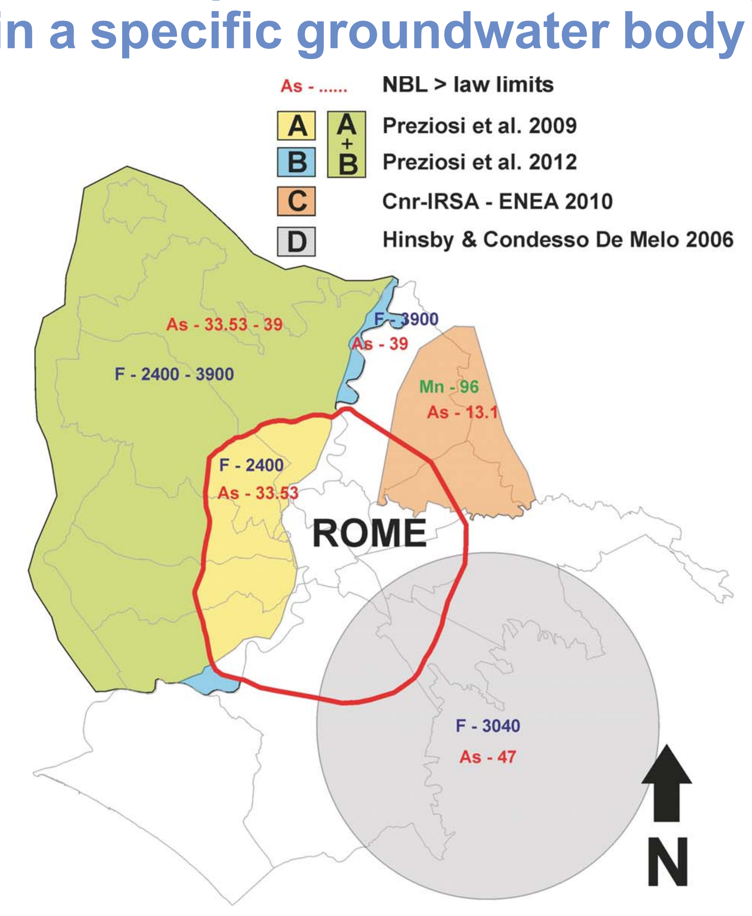

Fig. 3 Existing studies regardi NBLof groundwater in the territory of Roma Capitale

In the Latium Region the only commissioned studies, right now, are related to specific evaluation of thresholds of NBL for water supply and for some important potentially contaminated sites (IRSA/ENEA 2010), and moreover there are several scientific publications by research institutes and universities (Vivona et al. 2007, Preziosi et al. 2010, 2012, 2014, Hynsby and Condesso De Melo, 2006). Table 1 collects the results of main studies that are useful to define NBL values in groundwater in the area of Rome. Values indicate that there are some elements exceeding law limits, such as Mn (metal), As (semimetal), and F (non-metal) and others having significant concentrations such as V (metal) or B (semimetal).

Elements	Sector in Map				Italian Law D.Lgs 152/06 (environmental limits)	Italian Law human use limits
	A*	B+	C+	D*		
	µg/l					
F	2400	3900	700	3040	1500	1500
Cl	40,52	-	-	-	-	Cloruro 250000; Clorito 200
Ba	-	251,4	-	-	-	-
Be	-	0,1	0,07	-	4	-
B	-	231,7	651,5	-	1000	1000
Al	-	36,3	56,7	-	200	200
V	34,1	44,3	30,1	48,2	-	50
Cr	-	2,4	1,8	-	50	50
Mn	-	12,5	96	-	50	50
Fe	-	52,3	60,5	-	200	200
Ni	-	7,2	4,38	-	20	20
Cu	-	7,8	43,9	-	1000	1000
Zn	-	207,1	425,5	-	3000	-
As	33,53	39	13,1	47	10	10
Sr	-	1088,7	-	-	-	-
Rb	-	86,3	-	-	-	-
Se	-	2,1	0,9	-	10	10
Cd	-	0,1	0,065	-	5	5
Sb	-	0,9	0,68	-	5	5
U	-	12,6	18,3	-	-	-
Hg	-	0,3	-	-	1	1
Pb	-	0,5	1,16	-	10	10

Tab. 1 Results of existing studies about NBL of groundwater crossing the Roma Capitale territory. The methods used are represented by «» for «90th percentile» an by «+» for «95th percentile».*

Concluding, the lack of a general NBL aquifer zonation is a real problem related to the management of water supply and contaminated sites pressure.The best solution for the future NBL thresholds evaluation should be to planning a study regarding the whole territory and every existing aquifer; by the way, looking at the existing studies, inside or close the territory of Rome (even if they have not been conducted analyzing the same species and with the same method), it can be shown which is the area with data gap that must be firstly investigated in order to obtain a first NBL diffusion in the territory of Roma Capitale. Many data about groundwater quality, which could be easily used for these purposes are currently available at the Regional Environment Protection Agency (ARPA Lazio) and other local government authorities. These data could be a useful support to a scientific hydrogeological study which should be a good opportunity for government authorities to work together in order to apply the best groundwater management practices.

REFERENCES:

IRSA/ENEA (2010) Studi adottati dalla REGIONE LAZIO con Determina n.B2118 del 21/03/2011 ECO ITALIA 87 S.r.l. Integrazione Valori di Fondo Località Inviolata (Guidonia Montecelio)
Griffioen J, Passier HF, Klein J (2008) Comparison of Selection Methods To Deduce Natural Background Levels for Groundwater Units Environ. Science & Technology 42 (13)
Hinsby K, Condesso De Melo T. (2006) Application and evaluation of a proposed methodology for derivation of groundwater threshold values – a case study summary report- In Report of the EU project "BRIDGE" 2006 Deliverable 22 http://www.wfd-bridge.net
Hart A, Muller D (2006) BRIDGE Background cRiteria for the Identification of Groundwater thrEsholds. Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006).
Molinari A, Guadagnini L, Marcaccio M, Guadagnini A (2012) Natural background levels and thresholds values of chemical species in three large–scale groundwater bodies in Northern Italy. Sci. of the total environ., 425:9-19
Pirani G. and Vecchio A. (2009) - Determinazione dei valori di fondo per alcuni metalli e metalloidi nei terreni del Sito di Interesse Nazionale della Valle del Sacco – ISPRA Servizio Interdipartimentale per le Emergenze Ambientali - Settore Siti Contaminati
Preziosi E, Giuliano G, Vivona R (2010) Natural background levels and threshold values derivation for naturally As, V and F rich groundwater bodies: a methodological case study in Central Italy. Environmental Earth Science. DOI 10.1007/s12665-009-0404-y
Preziosi E, Ghergo S., Del Bon A. (2012) – Convenzione Regione Lazio IRSA/CNR-ENEA su indagini preliminari ad ampio spettro per la definizione dei valori di fondo geochimico naturale – areale esteso intorno a Malagrotta
Preziosi E, Parrone D, Del Bon A, Ghergo S. (2014) Natural background level assessment in groundwaters: probability plot versus pre-selection method, J.Geochemical exploration (in press)
Vivona R., Preziosi E, Madè B, Giuliano G (2007) Occurence of minor toxic elements in volcanic-sedimetary aquifers: a case study in Central Italy. Hydrogeology Journal. DOI 10.1007/s10040-007

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