Proceedings World Geothermal Congress 2000
Kyushu - Tohoku, Japan, May 28 - June 10, 2000

THE ITALIAN GEOTHERMAL DATABASE

Enrico Barbier[1], Stefano Bellani[1] and Fabio Musmeci[2]

[1]CNR-International Institute for Geothermal Research, Via Alfieri 1, 56010 Ghezzano (Pisa, Italy)
[2] ENEA- Department of Environment, Via Anguillarese 301, 00060 La Casaccia (Rome, Italy)

Keywords: Geothermal energy, geothermal resources, database, inventory.

ABSTRACT

The geothermal inventory ranks the Italian territory. The objective of the national database is to store information related to the location and characteristics of geothermal fluids in Italy. All the data gathered are stored in a computer database specifically set up for this purpose. The database includes wells that produce a geothermal fluid (hot water, steam or gas), geothermal or hydrocarbon exploratory wells, water wells above 30°C, unproductive wells, thermal springs and other manifestations. At the moment 2750 wells and about 570 thermal springs are included in the database with maps of temperature distribution at 1000, 2000, and 3000 m from ground level, and heat flow contours of all the Italian territory. The database is about 15 megabytes in size and is available on CD-ROMs for PCs under MS/DOS Windows 3.11 or Windows 95/98. The data management system used is the software Visual Basic with the Access engine, and can be hosted in any PC with at least 8 Mb of RAM.

1. INTRODUCTION

In 1986 the Italian Parliament voted a Bill to implement an assessment of national geothermal resources, with the aim to provide incentives for geothermal energy development. The objective of the inventory was to rank all Italian territory, integrate all data of geothermal interest, and organize them in a standard, readily accessible and readable format for the private and public user.

The four main organisations involved at that time in geothermal research and development, the National Research Council (CNR), the Italian Electric Power Company (ENEL), the Italian Agency for New Technologies, Energy and Environment (ENEA), and AGIP, the National Oil Company, collaborated in compiling the inventory of the Italian geothermal resources.

All the available and potentially useful geological, drilling, hydrogeological, geophysical and thermal data have been collected from geothermal and hydrocarbon wells, from thermal springs and other geothermal manifestations (e.g. fumaroles) (ENEL et al., 1988; CNR, 1994). Maps of Italian territory with temperature distribution at 1000, 2000, and 3000 m from ground level have been compiled using these data, together with a heat flow map and a geothermal ranking of the whole country.

2. THE NATIONAL GEOTHERMAL DATABASE

All the gathered data were stored in a computer database set up specifically for this purpose by CNR (the International Institute for Geothermal Research) and ENEA (Department of Environment) (Barbier and Musmeci, 1998). In the database the "obiects" are wells that produce a geothermal fluid (hot water, steam or gas), geothermal exploratory wells or hydrocarbon wells (AGIP, 1977), water wells above 30°C, and unproductive wells which can provide useful information on temperatures at depth in the area, and on the surface heat flow. Thermal springs and other manifestations are also classified as objects. At the moment 2750 wells and about 570 thermal springs are included in the database.

Each of the above objects is described through properties that show its essential features. In the case of a well, for instance, the properties include its name, geographic coordinates, altitude and depth, year of completion, mining results, the fluid temperature, the stratigraphy, the chemistry of any fluid produced, the drilling profile, etc.

Fifteen paper forms were designed to give a standard format to the data. These were originally collected on these forms and then loaded in the database.

The National Geothermal Database runs on a CD-ROM with a Windows 3.11 / Windows 95/98 application, capable of handling composite alphanumeric and geographical information, and taking full advantage of the Windows friendly interface of icons, buttons, and point/click interactions. The user - program interface is twofold: they can browse through the information stored on the CD, or add their own data to the database. In this latter case the user's hard disk must have a minimum of 20 megabytes disk space available for its installation.

The architectural choice is a relational database with main tables on wells and springs. In these tables each of the objects (wells and springs) is regarded as one record, and identified by a single ID numerical code as a key ("chiave" in Italian language). The identification table (main table, Fig. 1) provides general information about an object (its name, location, temperature, use, and several further characteristics).

Additional tables can be compiled with related information about temperatures (Fig. 2), heat flow, geological profile of the well (Fig. 3), chemistry of the fluid, and so on. They are linked to the main table through the same key, and actually behave as subdirectories of the main directory (the identification table), easily selectable through icons on the screen. On these additional tables a number of records may refer to the same object: for example, there may be several chemical or isotopic analyses of a fluid that were carried out

on different dates for the same spring (Fig. 4) or for the same well.

The full list of the related tables for wells and springs is the following:

- Identification and location data (wells and springs),
- Temperature data at depth (for wells only),
- Temperature gradient and heat flow data (wells only),
- Stratigraphic column of the well (wells only),
- Reservoir characteristics (wells only)
- Production of the well (wells only)
- Chemical, physical and isotopic characteristics of the water (or steam) discharged (wells and springs),
- Chemical, physical and isotopic characteristics of the gas discharged (wells and springs),
- Technical profile of the well (wells only),
- Correlation to vertical depths for deviated wells (wells only).

The user can define the criteria by which they wish to query the database (e.g. temperature >30°C and depth <1000 m). The output is a printable table that can also help in selecting a given object. The option of an automatic temperature-depth coloured graph has been added for each well, as well as a generalised coloured stratigraphic column. A further option is the extraction of selected portions of the database in files with text format (.txt).

The database also includes a GIS (Geographic Information System) which uses the same ID code of the object (the key). The GIS displays maps on which the locations of the selected wells and thermal springs/manifestations are easily identified by coloured symbols. A mouse click on each symbol displays all the information available on the chosen object. The database comprises a map of Italy showing the 20 Italian regions and the boundaries of the provinces, and 20 regional maps with the boundaries of the local administrations (counties). Any area can be zoomed in, out, or translated.

Contours of temperature distribution at 1000, 2000 (Fig. 5) and 3000 m from ground level, as well as heat flow contours of all of the Italian territory can be overlain on the regional maps.

From the main table the user can jump directly to the GIS and watch the selected object on the maps. For a quality analysis of the data entry, a family of functions is available to check the internal coherence of the data sets and to help to resolve any data conflicts. A context sensitive help function is also available to help the user. The help system is complete with a glossary.

At the moment, the National Geothermal Database is about 15 Megabytes in size and is available on CD-ROM to run on PC under MS/DOS Windows 3.11 or Windows 95/98. The data management system used is the software Visual Basic with the Access engine, and can be hosted in any PC with at least 8 megabytes of RAM.

3. REFERENCES

AGIP (1977) *Temperature sotterranee (Subterranean temperatures)*. AGIP, Milan, 1390 pp. and unpublished updates up to 1993.

Barbier, E. and Musmeci F. (1998) The Italian National Geothermal Database. *World Renewable Energy Congress Proceedings, Part IV*, Florence 20-25 September 1998, pp. 2737-2740.

CNR (National Resources Council of Italy) – International Institute for Geothermal Research (1994) *Aggiornamento dell'Inventario delle risorse geotermiche nazionali (Update of the Italian national geothermal resources inventory)*. Ministero dell'Industria, Rome, 3 reports + 8 maps.

ENEL, ENI-AGIP, CNR and ENEA (1988) *Inventario delle risorse geotermiche nazionali. Indagine d'insieme sul territorio nazionale (Inventory of the Italian national geothermal resources. Global survey of the national territory)*. Ministero dell'Industria, Rome, 75 pp. + enclosures.

DATI ANAGRAFICI DEL POZZO

DATI DI IDENTIFICAZIONE — CHIAVE 5341015

NOME PC 29 — TIPO (•) Produzione ( ) Esplorazione ( ) Gradiente termico ( ) Domestico ( ) Ignoto

LATITUDINE 425013 N — LONGITUDINE 114046 E — M. Mario 004622 W — Esatte ( ) Si ( ) No

Tmax (°C) 338 — a prof. (m) dal piano campagna 3500.00 — Quota del p.c. (m) 566 — PORTATA 21.4 ( ) kg/h (•) m³/h ( ) l/s ( ) kg/s
(Tmax proviene dalla scheda Dati Termometrici)

IN (•) Terra ( ) Acque interne ( ) Mare — REGIONE TOSCANA — PROVINCIA SIENA

COMUNE PIANCASTAGNAIO — CAMPO In senso minerario M.AMIATA

LOCALIZZAZIONE GEOGRAFICA

RIFERIMENTO TOPOGRAFICO IGM — FOGLIO 1:100.000 129 — TAVOLETTA IVSE — FOGLIO 1:200.000 4965

DATI DI PERFORAZIONE

PROPRIETARIO ENEL — DATA COMPLETAMENTO 23/12/1982 — PROFONDITA' (m) Sul percorso pozzo 3563

Calcolo Quota da Rotary

DATI ADDIZIONALI PER POZZI DEVIATI

PROFONDITA' INIZIO DEVIAZIONE (m) — PROFONDITA' DEL FONDO POZZO SULLA VERTICALE (m)

FONDO POZZO LATITUDINE N — LONGITUDINE E — M. Mario ? — Anno rilevamento dati o completamento pozzo

SCOPO
(•) Geotermico
( ) Acqua fredda
( ) Idrocarburi
( ) Minerario

ESITO MINERARIO
( ) Idrocarburi gassosi
( ) Anidride carbonica
( ) Acqua fredda
(•) Fluido geotermico
( ) Petrolio
( ) Industrialmente sterile
( ) Sterile

STATO DEL POZZO
(•) In produzione
( ) In prova
( ) Chiuso temporan.
( ) Cementato
( ) Esaurito
( ) In reiniezione
( ) Ostruito

USO
(•) Energia elettrica — ( ) Potabile — ( ) Stoccaggio
( ) Riscaldamento edifici — ( ) Agrozootecnico — ( ) Controllo
( ) Balneoterapeutico — ( ) Processi industriali — ( ) Nessuno

UTILIZZATORE

ANNI DI USO: da — a — mesi di utilizzo annuo

Fig. 1. Identification, location, mining and production data of a well.

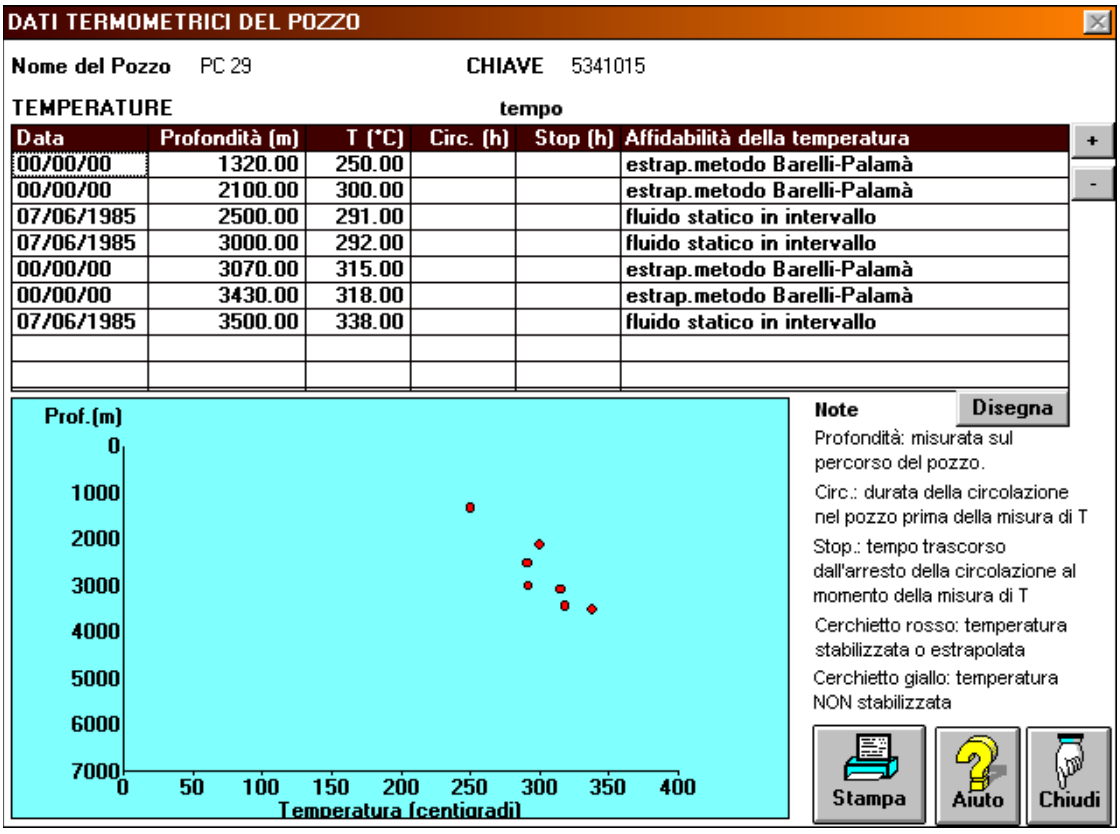


Fig. 2. Temperature-depth data from a well (the last column shows the reliability of temperature data).

SUCCESSIONE LITOSTRATIGRAFICA DEL POZZO

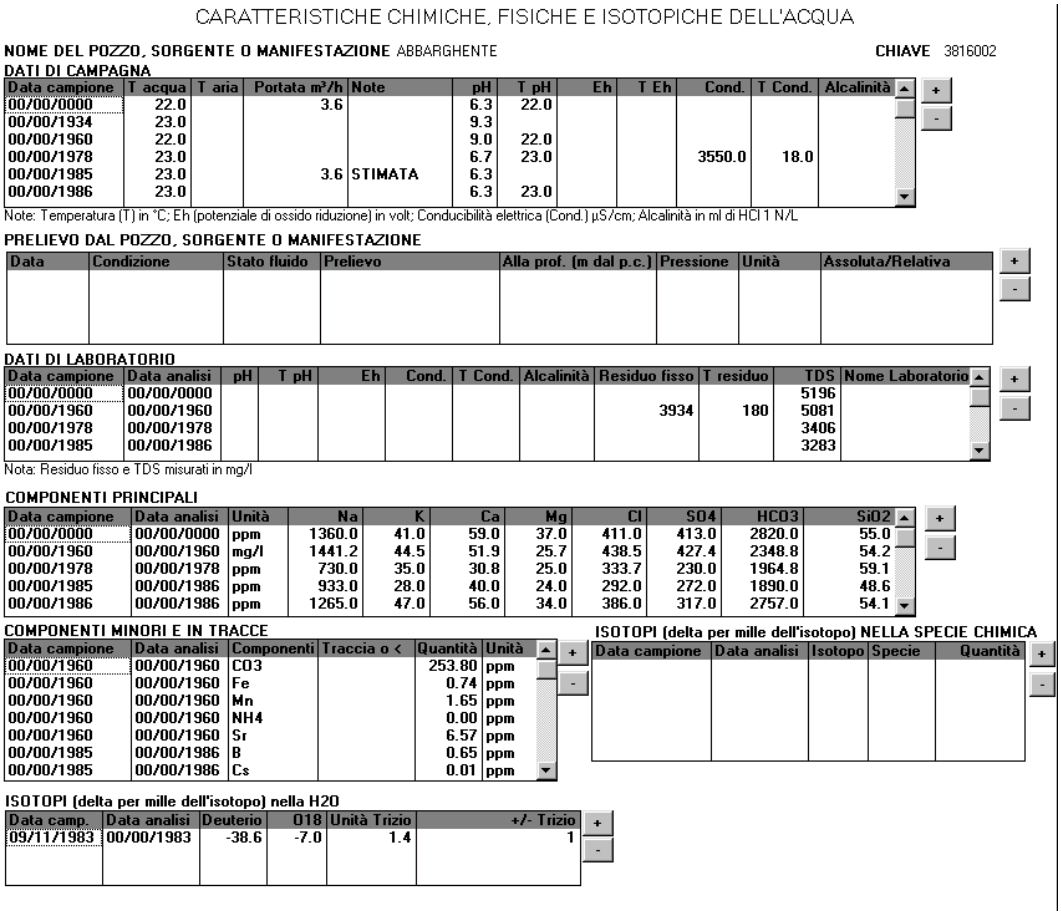
NOME DEL POZZO PC 29 — CHIAVE 5341015 — Scala grafica delle profondità (m): 500, 1000, 2000, 3000, 5000, 8000

Prof. (m)

Da	A	Litologia	Unità litostratigrafica
0.00	30.00	DETRITO	
30.00	240.00	ARGILLITI E CALCARI SILICEI	ARGILLE A PALOMBI
240.00	450.00	ARGILLITI,CALCARI E CALCARENITI	S.FIORA
450.00	1150.00	CALCARI DOLOMITICI ED ANIDRITI	CALCARE CAVERN.B
1150.00	1200.00	ANAGENITI E QUARZITI	VERRUCANO
1200.00	3563.25	FILLADI E METAGROVACCHE	FARMA

m dal p.c.: -500, -1000, -1500, -2000, -2500, -3000, -3500

Fig. 3. Lithological data and generalized stratigraphic column of a well.



CARATTERISTICHE CHIMICHE, FISICHE E ISOTOPICHE DELL'ACQUA

NOME DEL POZZO, SORGENTE O MANIFESTAZIONE ABBARGHENTE — CHIAVE 3816002

DATI DI CAMPAGNA

Data campione	T acqua	T aria	Portata m³/h	Note	pH	T pH	Eh	T Eh	Cond.	T Cond.	Alcalinità
00/00/0000	22.0		3.6		6.3	22.0					
00/00/1934	23.0				9.3						
00/00/1960	22.0				9.0	22.0					
00/00/1978	23.0				6.7	23.0			3550.0	18.0	
00/00/1985	23.0		3.6	STIMATA	6.3						
00/00/1986	23.0				6.3	23.0					

Note: Temperatura (T) in °C; Eh (potenziale di ossido riduzione) in volt; Conducibilità elettrica (Cond.) µS/cm; Alcalinità in ml di HCl 1 N/L

PRELIEVO DAL POZZO, SORGENTE O MANIFESTAZIONE

Data	Condizione	Stato fluido	Prelievo	Alla prof. (m dal p.c.)	Pressione	Unità	Assoluta/Relativa

DATI DI LABORATORIO

Data campione	Data analisi	pH	T pH	Eh	Cond.	T Cond.	Alcalinità	Residuo fisso	T residuo	TDS	Nome Laboratorio
00/00/0000	00/00/0000									5196	
00/00/1960	00/00/1960							3934	180	5081	
00/00/1978	00/00/1978									3406	
00/00/1985	00/00/1986									3283	

Nota: Residuo fisso e TDS misurati in mg/l

COMPONENTI PRINCIPALI

Data campione	Data analisi	Unità	Na	K	Ca	Mg	Cl	SO4	HCO3	SiO2
00/00/0000	00/00/0000	ppm	1360.0	41.0	59.0	37.0	411.0	413.0	2820.0	55.0
00/00/1960	00/00/1960	mg/l	1441.2	44.5	51.9	25.7	438.5	427.4	2348.8	54.2
00/00/1978	00/00/1978	ppm	730.0	35.0	30.8	25.0	333.7	230.0	1964.8	59.1
00/00/1985	00/00/1986	ppm	933.0	28.0	40.0	24.0	292.0	272.0	1890.0	48.6
00/00/1986	00/00/1986	ppm	1265.0	47.0	56.0	34.0	386.0	317.0	2757.0	54.1

COMPONENTI MINORI E IN TRACCE

Data campione	Data analisi	Componenti	Traccia o <	Quantità	Unità
00/00/1960	00/00/1960	CO3		253.80	ppm
00/00/1960	00/00/1960	Fe		0.74	ppm
00/00/1960	00/00/1960	Mn		1.65	ppm
00/00/1960	00/00/1960	NH4		0.00	ppm
00/00/1960	00/00/1960	Sr		6.57	ppm
00/00/1985	00/00/1986	B		0.65	ppm
00/00/1985	00/00/1986	Cs		0.01	ppm

ISOTOPI (delta per mille dell'isotopo) NELLA SPECIE CHIMICA

Data campione	Data analisi	Isotopo	Specie	Quantità

ISOTOPI (delta per mille dell'isotopo) nella H2O

Data camp.	Data analisi	Deuterio	O18	Unità Trizio	+/- Trizio
09/11/1983	00/00/1983	-38.6	-7.0	1.4	1

Fig. 4. Chemical, physical and isotopic characteristics of thermal water from a spring

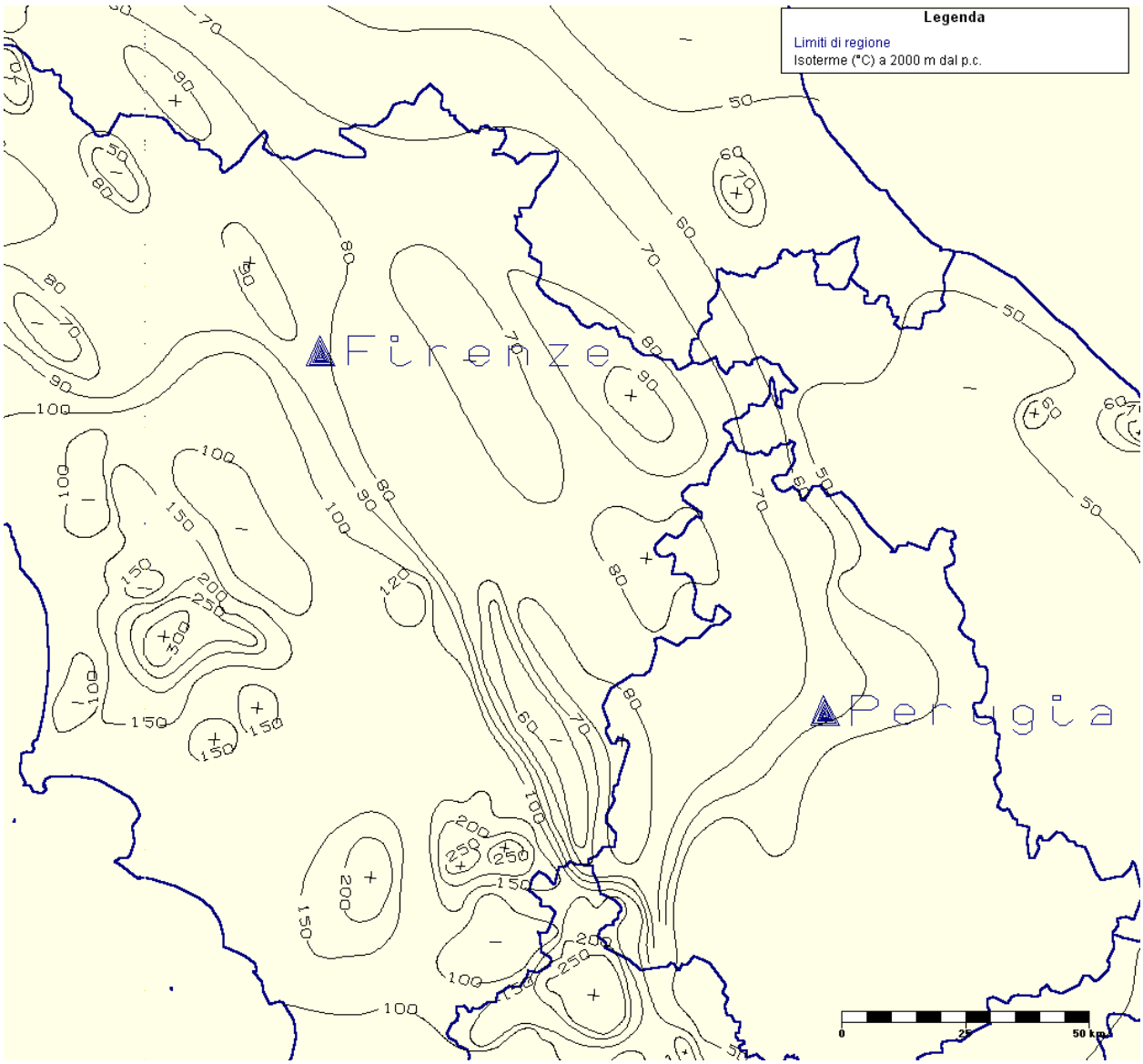


Fig. 5. Part of Central Italy with region boundaries (thicker lines) and temperature isolines at 2000 m b.g.l. (°C).