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EVIDENCE OF WATER VAPOUR AND ENDOGENETIC GASES FROM VENTS AND CRACKS IN THE USTICA ISLAND.

SUMMARY

One of the research programs of the Ustica Island Center for Studies and Documentation (Centro Studi e Documentazione Isola di Ustica) is to localize and describe the ancient fumarolas on this volcanic island. During this research some vents and cracks were discovered that emit low temperature water vapour and magmatic helium, and that probabily forms a system of subterranean cavities connected to crustal faults. This discovery is significant when we take into account that Ustica Island is the emergent part of a volcanic mountin that was active in the Pleistocene and has been extinct for more than 100.000 years. These formations are situated near faults related to the transtensive dynamic of the Southern Tyrrhenian Basin. It would be interesting to set up a geophysical and geochemical program on these geological structures in order to collect new data for the current studies on the Southern Tyrrhenian Basin.

Introduction

Ustica's Center of Study and Documentation, in the effort to give full value to the island naturalistic and archeologic patrimony, has started in 1997 a campaign to trace out and file, in the contest of Usticese volcanites, the marks from past fumaroles activities,which,accordingly to the oral and traditional documents, was manifested, probably in an intermittent manner, at least untill the first years of the 1900's, and after that apparently came to an end. Practically, old and new evidences are collected through consultation of documents and through interview to the local people; after this we go to direct identification in the soil, which was performed by V. Ailara and F. Foresta Martin, respectively Secretary and President of Ustica's Center of Study.

In the last decades the island of Ustica has been the object of numerous studies of volcanologic and geologic character. Thanks to those studies it has been possible to determine that the island represents the peak of an extended volcanic apparatus wich raises for about 650 feet from the bottom of the southern Tyrrenian basin. The Usticese volcanic activity start in the pleistocene, more then a million years ago, with rising of magma along some diffuse fractures on the bottom of the Tyrrenian prevalently oriented E-W and NE-SW (Barbieri and others,1969;Barbieri and Innocenti,1980;Romano and Sturiale,1971).Those native tectonics DIRETTRICI are still today find on some morphologic and structural characteristic of Ustica, like the allignment of the main eruptive center and the orientation of the axis of maximum elongation of the island of some costal lines and some faults.(pic.1).

Dating from about half million years ago, with the growing and coming afloat of the volcanic structure, the activity has changed from

subaqueous to subaerial continuing through numeous craters,the majority of which today not easily recognizable; and coming to a conclusion, about 130.000 years ago, with the last eruption of the Falconiera (De vita,1993) the only Usticese volcano that still preserves undamaged part of the crater.

Recent geologics and volcanologic studies on the island do not mention emissions from fumaroles or from other vents and cracks. To be able to find,in the scientific literature, signals of evident activities of the Usticesi fumaroles, one must go back to authors of the 1800's or first years of 1900's(Calcara,1842,Revelli 1908).We could deduct that, in the past century, there was a strong mitigation, if not a disappearance of those phenomenons. Therefore, when in 1997,we started the recognition to file the fumaroles, we thought we came across formations with marks ,if any, of past activities, but by this time lacking emissions.

Emission of Guardia dei Turchi's mountain.

For the reason above mentioned, we thought interesting and worthy to bring to notice to the scientific community the result achieved from our Center of Study in 1997, after several recognitions on the north side on Mountain Guardia dei Turchi, when we localized a group of vents showing evident discharge of air and vapor w ith temperatures in the interior of the cavity, low but superior to those of the surroundings, even on summer season (Foresta Martin,1998).Some openings have the appearance of small roundish vents other of thin cracks, provoked probably by volcano-tectonic collapses which, in different time, pounded the structure of Guardia dei Turchi's mountain.

Guardia dei Turchi's mountain,800 feet high, is the highest elevation in the island, is in a central position, and represent the relic of a composit volcano whose activity was engaged at first in low sea level sorroundings, then subaerial, between 520.000 and 475.000 years ago (Devita 1993). His summit shows a succession of faults with orientation N-S, and the vents that we find are in the proximity.

One can get confortably to mountain Guardia dei Turchi from the Case Vecchie quarter, taking the road to the Boschetto and going up the old trial which takes you to the radar complex of the civil aviation for control of aerial traffic.(‘*A palla* [The bowl], like the Usticesi name the dome that protect the building). When we get to altitude 650 feet, on the left there is a wall of basalt, while on the right side, toward valley, we see a ravine descending toward the large lawland of Tramontana, The numerous vents are just above the level of the old trail on the left,, just a few meters before an old stone bench encased in the rock. Some of those vents are visible and of diameter big enough that is possible to put your hand and part of the arm(pic.2).The flux of hot and humid air is so evident that it is enough to get close to the vent wearing a pair of glasses that you notice the moist condenseting on them. Going up the wall overhanging the trail, we get on top of a hill, which in local slang is called *u vurcanu*, formed from residues of a cone of dross and big basaltic blocks. The hot and humid emission can be found also in some of the cracks present in this formation.(pic.3)

Based on witnesses collected among the local elders, untill the beginning of 1900,on cold winter days, was a habit of farmers and sheperds to go and get warm near the vents of Guardia dei Turchi's mountain. During the month af January 1998,on some of the vents situated at the level of the trail, at altitude 650 feet we registered internal temperature of 93-103 degrees compared to external temperature of 49-59 degrees,

Just after the individualization of the described vents we asked ourself if the emissions observed were simply the result of hot air in the inside of natural cavities(Mannini,1998) or if was present emergence of endogenes gasses .The question mark could be only answered after geochemical inquiry, which in fact we have requested and which partially have been performed.

The first result in cronological order, relate to the presence of magmatic helium, derived from the relation 3H/4He,in a sample analyzed at the laboratory of Institute ef Geochimestry of cnr of Palermo, after Prof. M.P.Nuccio, appointed director of the rostrum of applyed Geochimestry of the University of Palermo, had accepted kindly our invitation to verify in person the emissions of Guardia dei Turchi's mountain. The isotopic ratio of helium, corrected for the air was:2.48 .Ra+-0.019; where Ra=3H/4 He=1.39.10-6 (Nuccio,1998, personal communication).

The second result derived from a work done independentily, from a group of reasearchers of Istituto Nazionale of Geophisic of Rome(ING) with the pourpose to measure flux of C02 and C04 from the soils of Ustica's island, due to the normal soil perspiration or to endogens factors. Well, regarding C02,the maximum flux was registered in the soil in proximity of the vents of Guardia dei Turchi' mountain and resulted to be of 243.000 t km2 a -1,to be compared with an average value, regarding the all island, of 34.000 t km2 a-1,and,again,to be compared with a maximum level of emission of the soils, in temperates climates, of 26.000 t km2 a-1 (Etiope and others,1999). Directly on the Guardia dei Turchi mountain's vents yet have not been performed measurements of C02, of C04 and of other emissions tipical of fumaroles activities.

A few months after our signalling in short, two independent measurements have stated that the emission from us mentioned even though they are dominated by a circulation of humid air overheated, are associated to elements and composites typical of volcanic and/or tectonic activities.

It is worthy to be mentioned that the hot exhalations saturated of vapor water coming afloat from Gurdia dei Turchi's mountain have favored the forming of micro-community of igrophile plants in the contest of a macro-community xerofitica, which is typical of climates and soils tendenciously arid.The first and concise description of those particular ecologycal niches are due to a visit on the spot in Ustica of Prof. Silvano Riggio, incumbent of rostrum of ecology in the usiversity of Palermo. The most interior part of the cavities are covered with a patina of dark-green cianobacteries. The outside of the cavity is framed with the sprouts of leafy lichens green-blu, mixed with selaginelle. In some interstices of the basaltic rock, close by the

cavity, are visible also some small fern.(Riggio,2001,personal communication).

The vents and cracks of Arso

Continuing in the research campaign, our Center of Study, in the months of november and december 1999, was able to locate several other vents characterized by emission of air and vapor water in the south western part of the island, on the edge of Arso (Foresta Martin,1999),in an area which present a particular importance from a tectonic point of view.(Pic.4). Arso, a tableland which develops on the south west coast of the island, with average height of 190 feet above sea level is formed by a footing of subaqueus volcanities, with the following one layng upon the other, flow of subaereal molten lava, piroclastiti and sedimentay deposit of a marine trasgression. From a structural point of view the most interesting aspect of Arso is given from the presence of a direct fault, with orientation NE-SW, more precisely N60oE(de Vita 1993),which fix the boundaries of the northern tableland and stand out like a slope which, for a length of about 1,100 feet, overtop the near trail.Traveling along this trail,in the stretch from the desalinetor to the lighthouse Punta Cavazzi, the Arso's tableland is on the left, displaced upper from the fault, while the trail is on the lower edge of the fault.

Accordingly with the most recent structural studies, the Arso's fault would be the result of local great tectonic stress, with character TRANSTENSIVO SINISTRO connected with the opening of the Thyrrenian sea (de Vita and others 1995). In short, a movement of TRANSTENSIONE is a combination of TRASCORRENZA with a DISTENSIONE. Practically, in the Arso's fault, the TRASCORRENZA permit the south edge, where the road is, to run toward SW, and the southern, where the tableland is, toward NE; instead the DISTENSIONE spread apart the two edges of the fault.

Even having in Arso the greatest obviousness, the fault would continue toward NE going through the all island, as is manifested, from the map of discharges of C02 and CH4, whose greatest peaks are closely correlated with this tectonic outline. In other words, the line of Arso's fault is visible because the great reascend of gasses also whereas she does not result visible in the surface (Etiope and others,1999). Besides, accordingly to the most recent explorations of the Thyrrenian bottom, done with tecnics of acustic waves reflection, the Arso's fault would continue also on both slopes of the great submerged volcanic structure of which Ustica is the emerging part. The Arso's fault, in short,could be considered the subaerial counterpart of a great coastal fracture which concern the Thyrrenian bottom.(Etipope and others,1999).

Associated with the Arso's fault there is a system of minor direct faults *en echelon*, that is in echelon, oriented N 25° E, which depart from it like a fish-bone affecting the Arso's southwest part and subdividing it in staircases descending toward west (de Vita,1993; de Vita and others 1995).Some of the vents detected by our Center of Study are on those staircases at altitude 170-190 feet and about 480 feet south of the desalinator. The easyest way to reach them, leaving from the desalinator, is identified by a basaltic cast which forms a

degrading trail toward the western coast(pic.5).The locality is called *vurnuredda*, that is small *vurni*, local dialectical expression with which are called the old reservoir, where the rain-water is collected. In this case the *vurnuredda* are absolutely natural, formed by concavities of some of the larger basaltic blocks which, after the rain, are filled with stagnant water.

From the Arso's vents, which appear like cracks rather irregular, incased in the basaltic blocks, emerge flux of air and vapor more consistent compared to those of Guardia dei Turchi's mountain. The internal temperature in the cavities, collected from us in the months of November and December 1999,were of 93-103 degrees compared with external temperature of 49-59.A first series of geochemical analysis, performed by ING just after our signalling, recorded on the vents on the higher altitude, an emission of air reaching fluxes of 30-40 liters per second, but no anomaly of neither CO2 nor CH4,although at the feet of the slope the value of those gasses accumulated in the soil offer considerable excess compared to the average value calculated for the island soil (already, previously mentioned).Evidently the flux of air canalized on the vents inspected are so strong to diluite completely the marking of endogenes gasses (Etiope, 2000, personal communication).

At the Arso's vents too were developed *enclaves* igrophile just similar to those present on the analogue formation of Guardia dei Turchi's mountain which, nevertheless, here appear poorer for the exposition to dominant sorrounding factor, like salty windsand and the greater isolation.

Conclusion

In the Island of Ustica exist a vast and capillary barbed-wire of subterranean channel intercommunicant which, most probably, include ancient ways of flux of magma and volcanics gasses, underground passages and grotto of marine erosion, etc.., and which result interconnected with the big and small faults of tectonic nature. It is clear from the first analysis performed on the openings, this system of channels, even though is crossed on some segments, by consistent flux of air,represent a way of coming afloat of enodogenes gasses of deep origin (magmatic helium).The presence of numeous vents and cracks immediately close by the faults of Guardia dei Turchi's mountain and Arso offer, in our opinion, the opportunity to conduct coordinated researches of geochemical and geophisic character. For example, the study on the correlation between the peaks of C02 and CH4 and the structural outline of the island, performed by the ING researchers (Etiope and others,1999),could now include measurements to be performed at the vents where the coming afloat of those gasses is non disturbed by flux of air.

Another fascinating possibility of studies, which we like to submit to the attention of the group of researchers interested, would be to install on the faults of Guardia dei Turchi and Arso a system of geophisic monitoring, and to carry out periodical sampling of geochemical character in the nearness of the vents.In this manner a more organic contribution for the geodinamic researches could be given and we could detect with more accuracy the recurring seismic

sequences that happen in the southern Tyrrenian which are experienced with particular effectiveness in the island, sometimes causing great problems for the civilian protection, like what happened in the early 1900's(G.Martinelli,1910).

An attention of this type would be largerly justified by the convincing of many scholar that Ustica is the only edge of emerged land where as the tectonics outlines present in the southern Thyrrenian basin could be traced and studied : a natural laboratory ideal to understand the geodinamic evolution of the entire region.