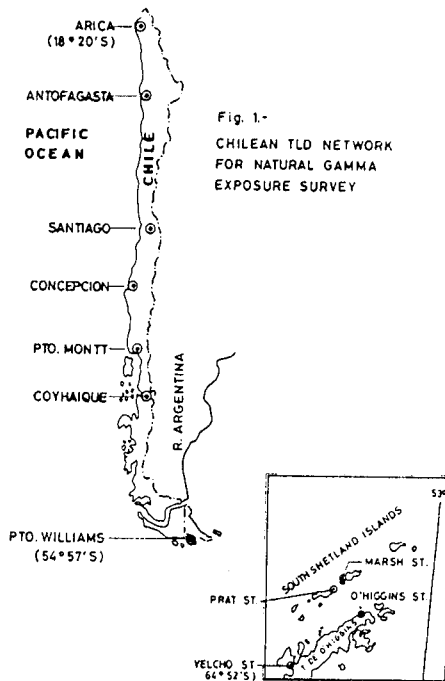


NATURAL RADIATION EXTERNAL EXPOSURES LEVELS  
IN CHILEAN SUB-ANTARTIC AND COUNTRY STATIONS

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Since 1983 gamma exposures levels, at 1,5 m above the soil are being investigated using TLD detectors. A network of 12 stations have been established from ARICA (18°20' S latitude) in Northern Chile to YELCHO (64°52' S latitude) in Antarctic territory. One year monitoring period was used at Antarctic stations and a four months period in the country. The main subject of this study is to assess the average background radiation levels along the territory which is relevant to get a reference level and specially an estimate of the average natural radiation contribution to the population dose in Southern Chile. Fig. 1 shows the TLD chilean network.



Method

The measurements were performed by two kind of TLD detectors : one energy compensated Ca SO<sub>4</sub>: Dy Teflon dosimeter and one uncompensated Ca F<sub>2</sub>: Dy, (TLD-200), the latter is required as a backup dosimeter and to assess any low energy gamma contamination. In this paper all our results are referred to the Ca SO<sub>4</sub>: Dy detector. The dosimeters were calibrated at the CCHEN Secondary Standard Laboratory, with a Cs-137 standard source, with ± 4% of uncertainty at 93% confidence. The usual annealing and preheat procedures as well as the fading, transit dose and self irradiation corrections were described elsewhere (Stuardo, 1984). An 8300 Teledyne Reader and a 2000 D Harshaw Analyser were used for dosimeter readings.

Results and Discussion

Fig. 2 shows the exposure levels (1986-87) with bar indicating the total estimated uncertainty. The Antarctic levels vary from ~ 0,6 pC Kg<sup>-1</sup> s<sup>-1</sup> at MARSH and PRAT stations to ~ 0,85 pC Kg<sup>-1</sup> s<sup>-1</sup> at O'HIGGINS and YELCHO stations. The former stations are located in a volcanic origin soil (South

Shetland Islands) and the latest ones in a soil having intrusive rocks composed mainly by granodiorite (Alarcón, 1976). Direct TLD measurements in rocks of Yelcho station give a  $0,95 \text{ pCi Kg}^{-1} \text{ s}^{-1}$  level which represents the upper exposure in the site and it is similar to the highest in the continental localities. The minimum exposure values, for the country stations, are found in Southern Chile ( $\sim 0,7 \text{ pC Kg}^{-1} \text{ s}^{-1}$ ) where the climate is rainy and the soil is mostly of volcanic origin. The maximum ( $\sim 1,0 \text{ pC Kg}^{-1} \text{ s}^{-1}$ ) corresponds to the northern localities with soil composed of stratified sediments.

Fig. 3 shows the annual average exposure levels (1983-87) along the territory. An increase of 40-60% is observed in 1985 to 1986 Antarctic levels and similarly in some of country stations (30-40%). The energy uncompensated Ca F2: Dy dosemeter did not detect any contribution of fresh radioactive contamination, then this variations can be attached to changes in stratospheric fallout plus some local changes in soil conditions, like: radon balance, ice and snow absorption thickness etc.

Table 1 presents the results of the annual mean gamma absorbed dose, for all the stations, as well as the total average dose  $\pm 1 \sigma$  over a period of 3 to 4 years. A factor of 0.956 was applied to the corrected exposure to evaluate the gamma absorbed dose (Vold, 80). In the Antarctic stations the average dose rate ranges between  $0.46 \text{ mGy Y}^{-1}$  (PRAT St.) and  $0.72 \text{ mGy Y}^{-1}$  (O'HIGGINS St.). These levels, correspond to 9% and 14% of the annual investigation limit for the public, respectively. In country stations the average dose rate fluctuates between 13% (PTO. MONTT) and 21% (SANTIAGO) of the limit.

For Southern Chile (Concepción to Pto. Williams), where most of people lives in wooden houses we consider an average dose rate of  $0.74 \text{ mGy Y}^{-1}$  which is equivalent, within the errors, to the  $0.65 \text{ mSv Y}^{-1}$  worldwide average normal dose equivalent, due to cosmic and terrestrial gamma radiation (UNSCEAR 82). In order to estimate the natural radiation contribution to the population dose, an average factor of 20% could be applied to outdoor levels of northern localities (Bouville, 85).

The annual fading factor of Ca SO<sub>4</sub>: Dy Teflon detector at Sub-Antarctic Stations, during a four year survey, is shown in Table 2. We observe that 50% of values differ from usual results found in Laboratory controlled experiments (Piesch 81).

#### Acknowledgements

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#### References

1. Alarcón B, Anbrus J., Viera C., 1976. "Geología del Estrecho de Gerlach entre  $64^\circ$  y  $65^\circ$  lat. Sur", Antártica Chilena. Serie Cient. INACH 4 (1), 7-46.
2. Bouville A, 1985. "Differentes composantes de la radioactivité naturelle et les fluctuations selon le lieu". Radioprotection, 20 (1) 21-31.
3. Piesch E., 1981 "Applications of TLD systems for environmental monitoring. Applied TLD Dosimetry. ECSC, EEC, Brussels, Luxemburg.
4. Stuardo E., 1984 "Mediciones de exposición  $\gamma$  en la Antártica Chilena Serie Científica. INACH. 31:9-21.
5. UNSCEAR, 1982, Ionizing Radiation: Sources and Biological Effects.

6. Vola E., 1980. "Energy dependence of TLD dosimetry in Environmental Monitoring. Natural Radiation Environment". III, Vol. 2, 965-985.

Fig. 2: NATURAL RADIATION EXTERNAL EXPOSURES LEVELS IN CHILE 1986-1987  
(Compensated CoSO<sub>4</sub> Dy detector)

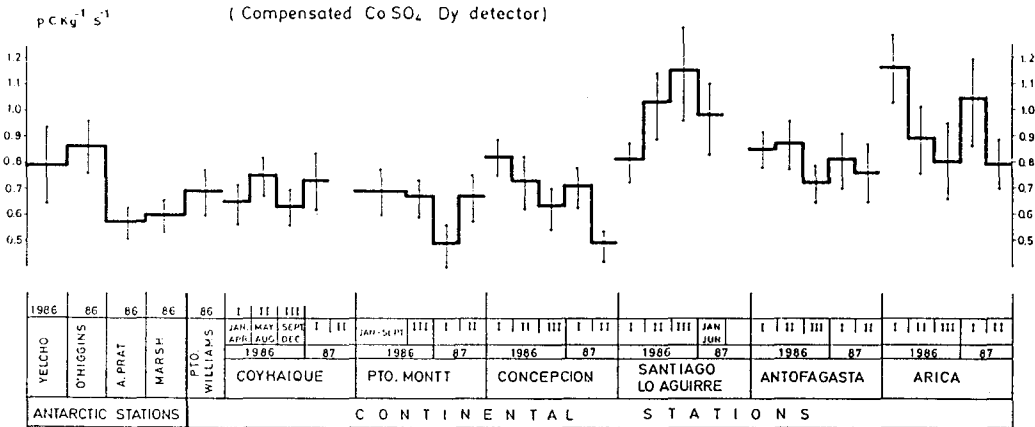


Fig. 3 NATURAL RADIATION EXPOSURES LEVELS IN CHILEAN ANTARCTIC AND CONTINENTAL STATIONS ANNUAL AVERAGE 1983-1986 (Compensated CaSO<sub>4</sub> Dy TLD detector)

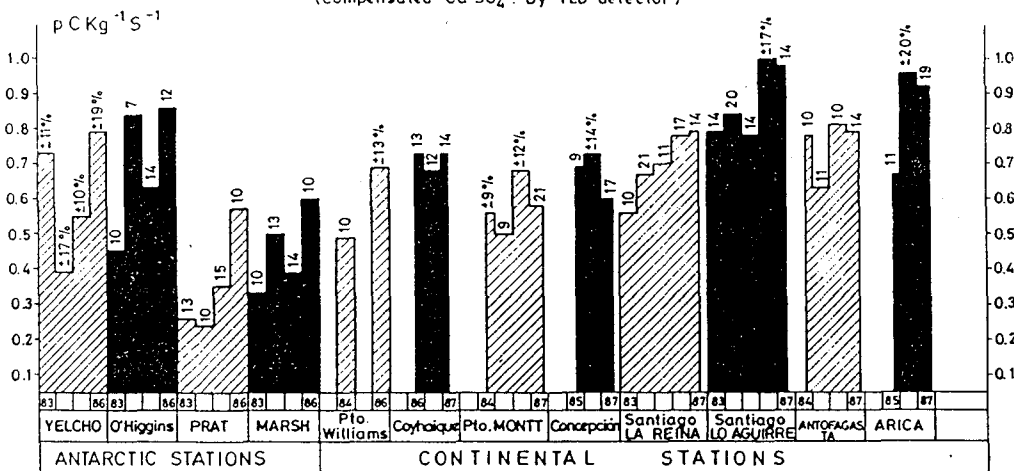


TABLE 1. NATURAL AVERAGE DOSE IN CHILEAN  
SUB-ANTARTIC AND CONTINENTAL STATIONS

STATION	ANNUAL mean dose (mCy.y <sup>-1</sup> )					Total average dose.
	1983	1984	1985	1986	1987	
YELCHO	0,85	0,45	0,63	0,92	---	mCy.y <sup>-1</sup> + 1σ 0,71 ± 0,21
O'HIGGINS	0,53	0,60	0,75	1,00	---	0,72 ± 0,21
PRAT	0,31	0,41	0,46	0,66	---	0,46 ± 0,15
MARSH	0,37	0,57	0,50	0,70	---	0,54 ± 0,14
PTO.WILLIAMS	---	0,57	---	0,80	---	0,69 ± 0,16
COYHAIQUE	---	---	0,81 (Aug-Dec)	0,78	0,85 (Jan-Apr)	0,81 ± 0,04
PTO.MONTT	---	0,65 (Sep-Dec)	0,57	0,79	0,68 (Jan-Aug)	0,67 ± 0,09
CONCEPCION	---	---	0,77 (Aug-Dec)	0,85	0,71 (Jan-Aug)	0,78 ± 0,07
SANTIAGO LO AGUIRRE	0,92	1,10	0,93	1,16	1,14 (Jan-Jun)	1,05 ± 0,12
ANTOFAGASTA	---	0,91 (Sep-Dec)	0,71	0,95	0,91 (Jan-Aug)	0,87 ± 0,11
ARICA	---	---	0,64 (Aug-Dec)	1,12	1,10 (Jan-Aug)	0,95 ± 0,27

TABLE 2. CHILEAN SUB-ANTARTIC STATIONS  
ANNUAL FADING IN CaSO<sub>4</sub>: Dy, TEFLON TL DETECTOR

YEAR \ STATION	MARSH	PRAT	O'HIGGINS	YELCHO
1983	(-1,6 °C) 1,36 < 163 >	(-2 °C) 1,05 < 283 >	(-3,1 °C) 1,06 < 568 >	(-1,2 °C) 1,05 < 389 >
1984	1,31 < 414 >	(1,7 °C) 1,05 < 458 >	1,21 < 244 >	1,31
1985	1,14	(-1,6 °C) 1,15 < 135 >	1,14	1,27
1986	1,25	1,26	1,15	---
Average ± 1σ	1,27 ± 0,09	1,13 ± 0,13	1,14 ± 0,06	1,21 ± 0,14

( ) annual average temperature  
< > annual snow precipitation in cm.