DISCUSSION


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The paper of Dockal (1995) is welcomed because it implies a new point of view to the old problem concerning $^{14}$C ages ranging between 25 and 40 Ka BP for a sea level higher than predicted by the classic Oxygen Isotope Curve (OIC). It is a ‘breath of fresh air’ to people like me, that have several $^{14}$C dates in this time span, for a sea level ranging between + 4 m and + 16 m a.s.l. between 33° to 41° South, on the Argentine Atlantic littoral.

Since they appeared, these ages were a true ‘hot potato’ in our hands, because they didn’t agree with the sea level pointed to this time span by the OIC. These ages have ‘mysterious’ origin to us (at this time working in the $^{14}$C laboratory of INGEIS, Argentina), because we didn’t accept the very simplistic argument historically used against them by most researchers. As these dates didn’t agree with the OIC, they were simply misconsidered with the repeated and ‘soft’ argument of “... some possible, but unknown $^{14}$C contamination.”

In spite of the ‘mystery’, we published the dates (Gonzalez et al., 1986). Meanwhile, we look for new data to either definitively discard or support the $^{14}$C measurements. In this way, we checked all possible laboratory and field contamination. Also we controlled several times the geological setting of the samples and other factors, like calcite/aragonite and $^{14}$C/$^{12}$C ratios in fossil and living shells of the same species; type of soil development on the studied deposits; etc. (Gonzalez et al., 1988).

In addition, samples coming from these deposits always range between 25 Ka and 38 Ka BP; meanwhile, samples coming from a well recognized subjacent transgression always indicate ages older than 43 Ka BP (technical limit of detection in our equipment). All our studies remarked the high reliability of the $^{14}$C data.

Dockal’s (1995) paper begins, supported by the ‘classic’ doubt concerning $^{14}$C ages ranging between 25 and 40 Ka BP, and states: “The chief problem is that above noted sites [he refers to the Atlantic U.S. coast] and samples indicate sea level standing at a higher elevation than is indicated by the oxygen isotope based sea level curve.” (Underlined by M.A.G.).

First, Dockal (1995) showed the high statistical reliability of these $^{14}$C dates. It is a heavy argument to disregard the possibility of contamination of the samples. We also applied this analysis (after Dockal, 1995) in our samples and the results are similar to his data (see Figure 1), again confirming in a new way the reliability of our $^{14}$C dates.

He developed a model supporting a possible cosmic effect on the Earth: during some past time prior to 25 to 40 Ka, our planet would have passed through a ‘wave’ of a supernova, supporting a high input of cosmic rays. That would enhance the production of cosmogenic nuclides, like $^{14}$C and $^{9}$Be. The large production of $^{14}$C would ‘rejuvenate’ the true ages coming from $^{14}$C measurements on tests of organisms living during that episode. He supported this model pointing that You et al. (1985), Raisbeck et al. (1987) and other researchers, found an anomalous ‘peak’ of $^{9}$Be in ice cores of Greenland and Antarctica, centered at around of 60 Ka BP.

Perhaps to people working on other subjects, the new hypothesis of Dockal (1995) seems a ‘solved problem’ concerning the ‘mystery’ involved in these ages. In spite of the importance of this new possibility, I wish to make some comments, especially because after the analysis of the dates shown by Dockal (1995), I find some unsolved questions.

COMMENTS

Concerning to the Possibility of Enhanced Production of Cosmogenic Radionuclides

Lao et al. (1992) also suggested that the production of cosmogenic radionuclides ($^{9}$Be and $^{14}$C) during the Last Glacial Maximum (LGM ~ 20,000 yr BP) would be increased, linked

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to changes in (a) solar activity and (b) Earth's magnetic field. The increase in \(^{10}\)Be would be around of 25% and, according to changes in (a) solar activity and (b) Earth’s magnetic field. The increase in \(^{10}\)Be would be around of 25% and, according Bard et al. (1990); in Lao et al., 1992), the increase in \(^{14}\)C would be around 40%. That increase in the rate of production of \(^{14}\)C would explain that \(^{14}\)C dates to LGM are 3500 yr younger than U/Th ones (Bard et al., 1990). These possible increases are very much lower than the 250 times of increase proposed by the hypothesis of Dockal (1995).

In addition and according to Brown et al., 1989 (in Lao et al., 1992), after being produced, \(^{10}\)Be is stripped from the atmosphere in few months. As specially remarked by Lao et al. (1992): “The deposition of \(^{10}\)Be onto the Earth’s surface varies considerably in time and place and is strongly influenced by local weather conditions. Consequently, the deposition rate of \(^{10}\)Be at any single site of land (for example in ice cores) may not reliably record changes in its global average production rate.” (Underlined by M.A.G.).

Concerning the above underlined paragraph, Lao et al. (1992) explicitly mentioned the works of You et al. (1985) and Raisbeck et al. (1987) that supported the hypothesis of Dockal (1995). Thus, while research supporting this ‘peak’ of \(^{10}\)Be in ice-cores is argued, any hypothesis based on this ‘peak’, like the supernova argument, also could be counter-argued.

**Concerning to the Representativity of the Considered Samples**

It is important to analyze the representativity of the samples considered by Dockal (1995), because it is the basis of any forthcoming study (see Gonzalez, 1992). In the following comments, two ages are considered similar, when accounting their respective methodological error (±) they agree in the same range (they have an overlap in the methodological error).

Dockal (1995), in Table 2 compared \(^{14}\)C ages (called ‘apparent’ ages) of his considered samples, with ages (called ‘corresponding’ ages) obtained by other methods such as thermoluminescence, \(^{230}\)Th/\(^{234}\)U, amino acid racemization and, also, the OIC. Fortunately, he indicates the origin of the samples in each case.

According to this table and misconsidering the dates of locality 7, with “non specified number of dates” (from 25,560 to 30,660 [yr BP]” (caption of table 2 in Dockal, 1995), the ‘corresponding’ ages to 50 ‘apparent’ ones came from samples as follows:

(a) **Seven cases with ‘corresponding’ ages coming from the same sample that ‘apparent’ ones.** Here the samples have the highest representativity. In five of these cases (71%), ‘apparent’ ages agree to ‘corresponding’ ones. In a range of four ages agree in around of 25/40 Ka (into the questioned time span); one age agrees around 60/70 Ka (this last one in locality 3). In the other two cases both, ‘apparent’ and ‘corresponding’ ages are nearly similar, ranging between 28,650 and 29,830 yr BP into the questioned time span.

(b) **Fourteen cases with ‘corresponding’ ages coming from the same site, same bed or feature, but sample different than the samples of the ‘apparent’ age.** These samples also have relative high representativity. In nine cases (64%) ‘apparent’ ages agree to their ‘corresponding’ ones and they are into the questioned time span. Only five ‘apparent’ ages (36%) didn’t agree to the ‘corresponding’ ones.

(c) **Ten cases with ‘corresponding’ ages coming from different beds or features than ‘apparent’ ones.** Here the representativity of the ‘corresponding’ samples to check the ‘apparent’ ages, would be questioned. Notwithstanding, in seven cases (70%) ‘apparent’ ages agree to their ‘corresponding’ ones, and they also are into the questioned time span.

(d) **Seven cases with ‘corresponding’ ages coming from the same lithologic unit or bed, close to the sampling site concerning to the ‘apparent’ ages.** Also, here the representativity of the ‘corresponding’ samples would be questioned. In spite of this, in five cases (71%), ‘apparent’ ages agree to their ‘corresponding’ ones; two are into the questioned time span and three are roughly between 75 Ka and 65 Ka.

(e) **Ten cases (and, probably, the “non specified number of dates” from site 7) with ‘corresponding’ ages coming from “... probably same lithologic unit but different and removed sites.”** The representativity of the ‘corresponding’ samples concerning the ‘apparent’ ones, is nearly ‘zero’. Not surprisingly (at least to a geologist...), in all these cases the ‘apparent’ ages didn’t agree to the ‘corresponding’ ones.

(f) **Two cases (first locality) with ‘corresponding’ ages coming from comparison with the OIC.** In one of that, both, ‘apparent’ and ‘corresponding’ ages, agree. In the other case and considering their respective methodological error, they also are very approximate, with a difference of only 2000 years. In both cases the ages are older than the questioned time span of 25/40 Ka, and ranging between 50 Ka and 75 Ka.

To conclude this point, note that 100% of the samples with the highest representativity (group a), ‘apparent’ and ‘corresponding’ ages are similar, or nearly similar. Furthermore, in 87% of the samples with relative high reliability (groups b, c and d), also the ‘apparent’ ages agree with the ‘corresponding’ ones.

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**Figure 1.** Distribution of finite radiocarbon dates from Late Pleistocene-marine deposits of the Atlantic littoral between 33° and 41° South, Argentina (after Dockal, 1995). The dates were detailed in Gonzalez et al. (1986, 1988) and in Gonzalez and Guida (1990).
Concerning the Dates

In addition, from the data commented above, it is possible to make additional comments concerning to the dates:

(g) In 30 of these 50 cases, (60%) 'apparent' ages directly agree, or are nearly similar to the corresponding ones. Further, in 25 of these cases, (50%) the ages are into the questioned time span of 25 ka to 40 ka.

(h) In addition, five 'apparent' ages agree with their corresponding ones and range between 74.7 ka (Locality 3) and 58.8 ka (Locality 4).

These additional comments allow complementary questions.

First, in most cases shown by Dockal (1995) and especially in the more representative samples, 'apparent' $^{13}C$ ages directly agree, or are nearly similar, with the corresponding ones. Surprisingly (?) they are within the questioned time span of 25/40 ka. With only this argument, it would be possible to support that $^{13}C$ dates are valid, not 'apparents'.

Second: Five 'apparent' $^{13}C$ dates ranging between 61 ka and 74.7 ka also agree with their corresponding ones. Thus, if we accept the hypothesis of the Earth involved in the 'wave' of a supernova in around 60 ka, as suggested by Dockal (1995), why have these five samples similar $^{13}C$ ages to those coming from other methods? Why were they not rejuvenated, as was supposed to younger $^{13}C$ dates?

Third: One of the two 'apparent' ages for the first locality agree with that corresponding age coming from...the oxygen isotope curve! It is in around of 70 ka. How can this agreement be explained? When $^{13}C$ dates agree with the OIC, in spite of its very proximity to the limit of the best improved methods of detection, the age is valid, and when they don't agree with the OIC it is erroneous, instead of any other argument!

Final Comments

Further to the mentioned works carried out by our group, we performed complementary magnetostratigraphic measurements of samples from a well studied outcrop and the results were exposed by Gonzalez and Guida (1990). At this locality there are estuarine silts and a tephra layer, both with a well recorded reversal magnetic field event. The virtual paleo-pole position of that, agrees with the Blake Event recorded at Grand Pile (Dr. N. A. Moerner, written communication). This reversal event was dated in around 114,000 yr BP (Moerner, 1977, and others; see Gonzalez and Guida, 1992); this age agrees with the final part of the Sangamon Interglacial, and allow us to consider a younger age to the overlapped transgressive deposits.

These last ones have basal $^{13}C$ ages of 35,400 ± 1800 and 32,700 ± 1300 yr BP, and 26,600 ± 720 yr BP in the top (Gonzalez and Guida, 1990). The second deposits are magnetostrically well differentiated from the basal ones. They record an excursion of the earth's magnetic field, that would indicate a possible reversal episode younger than the Blake Event. This could agree with the Lake Mungo excursion, precisely found around 30 ka BP and in coincidence with the questioned time span (Smith and Foster, 1969; Barbetti and McElhinny, 1972, and others; see Gonzalez and Guida, 1990).

To conclude, the new idea introduced by Dockal (1995), impulses new wishes to look for supporting data in all the involved research fields. In this way, we don't forget that any laboratory analysis will be only valid if it is supported on reliable field data and if it is performed on samples representative of the studied problem. In addition, a brilliant idea like the Oxygen Isotope Curve, should not blind our minds. There are other elements that would influence sea level in this time span, for instance, tectonic-eustasy and hydro-isostasy, if that 'anomalous' sea level has global evidence; geodeic eustasy, if it is only an Atlantic 'anomaly' (the so called 'Atlantic disease').

LITERATURE CITED


