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CARBON ISOTOPIC RESEARCH OF *PINUS SYLVESTRIS* L. GROWING IN THE SOUTHERN POLAND (NEAR KĘDZIERZYN-KOŻŁE, DĄBROWA GÓRNICZA KATOWICE AND OLESNO)

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ABSTRACT. In this paper we present data from the measurements of carbon isotopes ($\Delta^{14}\text{C}$ and $\delta^{13}\text{C}$) from α -cellulose extracted from pine tree-rings. The samples were collected in four forests located in the most industrialized part of Poland, where coal mining and coal-based energy are an important branch of industry. The investigated period of time (1975–2012) covers the period of development in coal mining and other industry sectors. Stable isotope composition has been determined with using IRMS and radiocarbon concentration was determinate by AMS.

KEYWORDS: date list, pine, radiocarbon, spectrometry, stable isotopes.

INTRODUCTION

We list below ^{14}C and $\delta^{13}\text{C}$ results of the measurements of the annual rings of Scots pine (*Pinus sylvestris* L.) from Kędzierzyn-Koźle (50°20'N, 18°19'E), Hutki Kanki (50°24'N, 19°28'E) near Dąbrowa Górnicza, Podlesie (50°10'N, 18°58'E) near Katowice and Olesno (50°48'N, 18°23'E), Poland. The Silesian region is a highly populated and industrialized area. The investigated period of time (1975–2012) covers the period of industrial development and implementation of pro-ecological policy in the industrial sector. The three sampling sites: Kędzierzyn-Koźle, Dąbrowa Górnicza, and Podlesie, are located in a highly industrialized area, whereas Olesno is 100 km away from factories. In Kędzierzyn-Koźle there are chemical (nitrogen and petrochemical) factories, whereas near Dąbrowa Górnicza there is a steelworks and coking plant, and Podlesie is located near a combined heat and power plant. The analysis of annual tree-rings of pine (*Pinus sylvestris* L.) was performed at the Silesian University of Technology in Gliwice. M. Opała and S. Wilczyński provided the samples and their chronology (Sensuła et al. 2015a, 2015b; Sensuła and Wilczyński 2018). The dendrochronologically dated annual tree rings were manually separated, pooled, homogenized, and cut into small pieces. α -cellulose samples were extracted (from 10 trees per site) by applying procedures based on Green's method (1963) used in the mass spectrometry laboratory of the Silesian University of Technology (Sensuła and Wilczyński 2017). The stable isotopic compositions of annual tree rings were analyzed with annual resolution for the period 1975–2012. The ^{14}C isotopic compositions of annual tree rings α -cellulose were analyzed by AMS with annual resolution for the period 2000–2012 and for each 5th year resolution for the period 1975–2000 (Sensuła et al. 2018; Sensuła and Wilczyński 2018).

Samples of α -cellulose were converted to graphite for AMS ^{14}C measurements (Piotrowska 2013; Sensuła et al. 2018). The process was performed using an AGE automated graphitization system (Wacker et al. 2010). Oxalic Acid II (NIST SRM4990C) was used as a reference material. ^{14}C concentrations were determined at the DirectAMS laboratory, Bothell, WA, USA (Zoppi et al. 2010). Three to four graphites of blank and OxII were

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measured in the same run as unknown α -cellulose samples. The average blank for these series was 0.3 pMC, which corresponds to 46.6 ka BP, and this value was subtracted from measured concentrations. $\delta^{13}\text{C}$ were determined using an Isoprime continuous flow isotope ratio mass spectrometer (GV Instruments, Manchester, UK) at the mass spectrometry laboratory of the Silesian University of Technology.

RESULTS

The results are listed in Tables 1–4 in the appendix.

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APPENDIX

Table 1 Tree-ring samples collected near Kędzierzyn-Koźle (50°20'N,18°19'E), from *Pinus sylvestris* L. (Sensuła et al. 2018).

Sample details	Δ data	$\delta^{13}\text{C}$ data
Tree Ring KK_2012. Growth year: 2012. GdA-3814	$\Delta = 32.1 \pm 2.8\text{‰}$	$\delta^{13}\text{C} = -24.11 \pm 0.09\text{‰}$
Tree Ring KK_2011. Growth year: 2011. GdA-3815	$\Delta = 33.7 \pm 2.6\text{‰}$	$\delta^{13}\text{C} = -24.49 \pm 0.14\text{‰}$
Tree Ring KK_2010. Growth year: 2010. GdA-3816	$\Delta = 42.1 \pm 2.7\text{‰}$	$\delta^{13}\text{C} = -24.59 \pm 0.23\text{‰}$
Tree Ring KK_2009. Growth year: 2009. GdA-3817	$\Delta = 38.3 \pm 2.6\text{‰}$	$\delta^{13}\text{C} = -24.6 \pm 0.06\text{‰}$
Tree Ring KK_2008. Growth year: 2008. GdA-3818	$\Delta = 51.1 \pm 2.7\text{‰}$	$\delta^{13}\text{C} = -24.3 \pm 0.05\text{‰}$
Tree Ring KK_2007. Growth year: 2007. GdA-3819	$\Delta = 58.3 \pm 3\text{‰}$	$\delta^{13}\text{C} = -24.21 \pm 0.04\text{‰}$
Tree Ring KK_2006. Growth year: 2006. GdA-3820	$\Delta = 56.9 \pm 2.7\text{‰}$	$\delta^{13}\text{C} = -24.47 \pm 0.02\text{‰}$
Tree Ring KK_2005. Growth year: 2005. GdA-3821	$\Delta = 59.9 \pm 2.8\text{‰}$	$\delta^{13}\text{C} = -24.2 \pm 0.06\text{‰}$
Tree Ring KK_2004. Growth year: 2004. GdA-3822	$\Delta = 68.5 \pm 2.7\text{‰}$	$\delta^{13}\text{C} = -24.03 \pm 0.03\text{‰}$
Tree Ring KK_2003. Growth year: 2003. GdA-3823	$\Delta = 74.3 \pm 2.6\text{‰}$	$\delta^{13}\text{C} = -23.57 \pm 0.12\text{‰}$
Tree Ring KK_2002. Growth year: 2002. GdA-3824	$\Delta = 78.7 \pm 2.9\text{‰}$	$\delta^{13}\text{C} = -23.64 \pm 0.09\text{‰}$
Tree Ring KK_2001. Growth year: 2001. GdA-3825	$\Delta = 79.3 \pm 2.6\text{‰}$	$\delta^{13}\text{C} = -24.63 \pm 0.08\text{‰}$
Tree Ring KK_2000. Growth year: 2000. GdA-3826	$\Delta = 89.5 \pm 3\text{‰}$	$\delta^{13}\text{C} = -24.51 \pm 0.06\text{‰}$
Tree Ring KK_1999. Growth year: 1999.		$\delta^{13}\text{C} = -24.17 \pm 0.03\text{‰}$
Tree Ring KK_1998. Growth year: 1998.		$\delta^{13}\text{C} = -24.26 \pm 0.05\text{‰}$
Tree Ring KK_1997. Growth year: 1997.		$\delta^{13}\text{C} = -24.17 \pm 0.07\text{‰}$
Tree Ring KK_1996. Growth year: 1996.		$\delta^{13}\text{C} = -24.1 \pm 0.16\text{‰}$
Tree Ring KK_1995. Growth year: 1995. GdA-4317	$\Delta = 110.4 \pm 3\text{‰}$	$\delta^{13}\text{C} = -23.86 \pm 0.24\text{‰}$
Tree Ring KK_1994. Growth year: 1994.		$\delta^{13}\text{C} = -23.36 \pm 0.12\text{‰}$
Tree Ring KK_1993. Growth year: 1993.		$\delta^{13}\text{C} = -23.53 \pm 0.2\text{‰}$
Tree Ring KK_1992. Growth year: 1992.		$\delta^{13}\text{C} = -23.36 \pm 0.11\text{‰}$
Tree Ring KK_1991. Growth year: 1991.		$\delta^{13}\text{C} = -23.36 \pm 0.15\text{‰}$
Tree Ring KK_1990. Growth year: 1990. GdA-4316	$\Delta = 143.4 \pm 3.6\text{‰}$	$\delta^{13}\text{C} = -23.45 \pm 0.02\text{‰}$
Tree Ring KK_1989. Growth year: 1989.		$\delta^{13}\text{C} = -23.53 \pm 0.12\text{‰}$
Tree Ring KK_1988. Growth year: 1988.		$\delta^{13}\text{C} = -23.61 \pm 0.13\text{‰}$
Tree Ring KK_1987. Growth year: 1987.		$\delta^{13}\text{C} = -23.81 \pm 0.08\text{‰}$
Tree Ring KK_1986. Growth year: 1986. GdA-4315	$\Delta = 192.9 \pm 3.3\text{‰}$	$\delta^{13}\text{C} = -23.79 \pm 0.03\text{‰}$
Tree Ring KK_1985. Growth year: 1985. GdA-4314	$\Delta = 207 \pm 3.8\text{‰}$	$\delta^{13}\text{C} = -23.78 \pm 0.03\text{‰}$
Tree Ring KK_1984. Growth year: 1984.		$\delta^{13}\text{C} = -23.68 \pm 0.03\text{‰}$
Tree Ring KK_1983. Growth year: 1983.		$\delta^{13}\text{C} = -23.24 \pm 0.07\text{‰}$
Tree Ring KK_1982. Growth year: 1982.		$\delta^{13}\text{C} = -23.61 \pm 0.07\text{‰}$
Tree Ring KK_1981. Growth year: 1981.		$\delta^{13}\text{C} = -24.07 \pm 0.02\text{‰}$
Tree Ring KK_1980. Growth year: 1980. GdA-4313	$\Delta = 282.8 \pm 3.9\text{‰}$	$\delta^{13}\text{C} = -24.16 \pm 0.03\text{‰}$
Tree Ring KK_1979. Growth year: 1979.		$\delta^{13}\text{C} = -23.69 \pm 0.07\text{‰}$
Tree Ring KK_1978. Growth year: 1978.		$\delta^{13}\text{C} = -23.86 \pm 0.05\text{‰}$
Tree Ring KK_1977. Growth year: 1977.		$\delta^{13}\text{C} = -23.9 \pm 0.03\text{‰}$
Tree Ring KK_1976. Growth year: 1976.		$\delta^{13}\text{C} = -23.96 \pm 0.12\text{‰}$
Tree Ring KK_1975. Growth year: 1975. GdA-4312	$\Delta = 409.3 \pm 3.7\text{‰}$	$\delta^{13}\text{C} = -23.96 \pm 0.04\text{‰}$

Table 2 Tree-ring samples collected near Hutki Kanki (50°24'N,19°28'E) near Dąbrowa Górnicza from *Pinus sylvestris* L. (Sensuła et al. 2018).

Sample details	Δ data	$\delta^{13}\text{C}$ data
Tree Ring HK_2012. Growth year: 2012. GdA-3827	$\Delta = 32.5 \pm 2.7\text{‰}$	$\delta^{13}\text{C} = -24.04 \pm 0.16\text{‰}$
Tree Ring HK_2011. Growth year: 2011. GdA-3828	$\Delta = 34.9 \pm 2.6\text{‰}$	$\delta^{13}\text{C} = -24.64 \pm 0.11\text{‰}$
Tree Ring HK_2010. Growth year: 2010. GdA-3829	$\Delta = 50.6 \pm 3\text{‰}$	$\delta^{13}\text{C} = -25.33 \pm 0.15\text{‰}$
Tree Ring HK_2009. Growth year: 2009. GdA-3830	$\Delta = 46.2 \pm 2.8\text{‰}$	$\delta^{13}\text{C} = -24.85 \pm 0.16\text{‰}$
Tree Ring HK_2008. Growth year: 2008. GdA-3831	$\Delta = 49.9 \pm 2.9\text{‰}$	$\delta^{13}\text{C} = -24.78 \pm 0.06\text{‰}$
Tree Ring HK_2007. Growth year: 2007. GdA-3832	$\Delta = 57.9 \pm 3\text{‰}$	$\delta^{13}\text{C} = -24.1 \pm 0.07\text{‰}$
Tree Ring HK_2006. Growth year: 2006. GdA-3833	$\Delta = 58.5 \pm 2.8\text{‰}$	$\delta^{13}\text{C} = -23.9 \pm 0.11\text{‰}$
Tree Ring HK_2005. Growth year: 2005. GdA-3834	$\Delta = 57.3 \pm 2.9\text{‰}$	$\delta^{13}\text{C} = -24.14 \pm 0.06\text{‰}$
Tree Ring HK_2004. Growth year: 2004. GdA-3835	$\Delta = 72.2 \pm 2.7\text{‰}$	$\delta^{13}\text{C} = -24.23 \pm 0.17\text{‰}$
Tree Ring HK_2003. Growth year: 2003. GdA-3836	$\Delta = 73.1 \pm 3\text{‰}$	$\delta^{13}\text{C} = -23.53 \pm 0.09\text{‰}$
Tree Ring HK_2002. Growth year: 2002. GdA-3837	$\Delta = 71 \pm 3.2\text{‰}$	$\delta^{13}\text{C} = -24.26 \pm 0.13\text{‰}$
Tree Ring HK_2001. Growth year: 2001. GdA-3838	$\Delta = 79.6 \pm 3.1\text{‰}$	$\delta^{13}\text{C} = -24.3 \pm 0.43\text{‰}$
Tree Ring HK_2000. Growth year: 2000. GdA-3839	$\Delta = 83.3 \pm 3.2\text{‰}$	$\delta^{13}\text{C} = -23.77 \pm 0.02\text{‰}$
Tree Ring HK_1999. Growth year: 1999.		$\delta^{13}\text{C} = -23.71 \pm 0.18\text{‰}$
Tree Ring HK_1998. Growth year: 1998.		$\delta^{13}\text{C} = -23.82 \pm 0.01\text{‰}$
Tree Ring HK_1997. Growth year: 1997.		$\delta^{13}\text{C} = -24.14 \pm 0.07\text{‰}$
Tree Ring HK_1996. Growth year: 1996.		$\delta^{13}\text{C} = -23.93 \pm 0.01\text{‰}$
Tree Ring HK_1995. Growth year: 1995. GdA-4311	$\Delta = 130.1 \pm 3.8\text{‰}$	$\delta^{13}\text{C} = -23.58 \pm 0.13\text{‰}$
Tree Ring HK_1994. Growth year: 1994.		$\delta^{13}\text{C} = -23.7 \pm 0.06\text{‰}$
Tree Ring HK_1993. Growth year: 1993.		$\delta^{13}\text{C} = -23.35 \pm 0.02\text{‰}$
Tree Ring HK_1992. Growth year: 1992.		$\delta^{13}\text{C} = -22.89 \pm 0.1\text{‰}$
Tree Ring HK_1991. Growth year: 1991.		$\delta^{13}\text{C} = -23.57 \pm 0.01\text{‰}$
Tree Ring HK_1990. Growth year: 1990. GdA-4310	$\Delta = 159.1 \pm 3.4\text{‰}$	$\delta^{13}\text{C} = -24.2 \pm 0.09\text{‰}$
Tree Ring HK_1989. Growth year: 1989.		$\delta^{13}\text{C} = -23.88 \pm 0.13\text{‰}$
Tree Ring HK_1988. Growth year: 1988.		$\delta^{13}\text{C} = -23.68 \pm 0.01\text{‰}$
Tree Ring HK_1987. Growth year: 1987.		$\delta^{13}\text{C} = -23.6 \pm 0.32\text{‰}$
Tree Ring HK_1986. Growth year: 1986. GdA-4309	$\Delta = 197.8 \pm 3.6\text{‰}$	$\delta^{13}\text{C} = -24.35 \pm 0.09\text{‰}$
Tree Ring HK_1985. Growth year: 1985. GdA-4308	$\Delta = 198.8 \pm 3.8\text{‰}$	$\delta^{13}\text{C} = -24.66 \pm 0.2\text{‰}$
Tree Ring HK_1984. Growth year: 1984.		$\delta^{13}\text{C} = -24.32 \pm 0.18\text{‰}$
Tree Ring HK_1983. Growth year: 1983.		$\delta^{13}\text{C} = -23.04 \pm 0.04\text{‰}$
Tree Ring HK_1982. Growth year: 1982.		$\delta^{13}\text{C} = -23.26 \pm 0.18\text{‰}$
Tree Ring HK_1981. Growth year: 1981.		$\delta^{13}\text{C} = -23.87 \pm 0.07\text{‰}$
Tree Ring HK_1980. Growth year: 1980. GdA-4307	$\Delta = 285.2 \pm 3.6\text{‰}$	$\delta^{13}\text{C} = -24.27 \pm 0.05\text{‰}$
Tree Ring HK_1979. Growth year: 1979.		$\delta^{13}\text{C} = -24 \pm 0.06\text{‰}$
Tree Ring HK_1978. Growth year: 1978.		$\delta^{13}\text{C} = -23.86 \pm 0.05\text{‰}$
Tree Ring HK_1977. Growth year: 1977.		$\delta^{13}\text{C} = -24.6 \pm 0.23\text{‰}$
Tree Ring HK_1976. Growth year: 1976.		$\delta^{13}\text{C} = -23.87 \pm 0.07\text{‰}$
Tree Ring HK_1975. Growth year: 1975. GdA-4306	$\Delta = 399.6 \pm 3.6\text{‰}$	$\delta^{13}\text{C} = -24.18 \pm 0.15\text{‰}$

Table 3 Tree-ring samples collected near Podlesie (50°10'N,18°58'E) near Katowice from *Pinus sylvestris* L. (Sensuła et al. 2018).

Sample details	Δ data	$\delta^{13}\text{C}$ data
Tree Ring LA_2012. Growth year: 2012. GdA-3840	$\Delta = 34.2 \pm 3.2\text{‰}$	$\delta^{13}\text{C} = -23.5 \pm 0.16\text{‰}$
Tree Ring LA_2011. Growth year: 2011. GdA-3841	$\Delta = 25.7 \pm 3.2\text{‰}$	$\delta^{13}\text{C} = -24.25 \pm 0\text{‰}$
Tree Ring LA_2010. Growth year: 2010. GdA-3842	$\Delta = 40.5 \pm 3.5\text{‰}$	$\delta^{13}\text{C} = -24.37 \pm 0.04\text{‰}$
Tree Ring LA_2009. Growth year: 2009. GdA-3843	$\Delta = 42.1 \pm 3.1\text{‰}$	$\delta^{13}\text{C} = -24.37 \pm 0.05\text{‰}$
Tree Ring LA_2008. Growth year: 2008. GdA-3844	$\Delta = 28.7 \pm 3.1\text{‰}$	$\delta^{13}\text{C} = -24.01 \pm 0\text{‰}$
Tree Ring LA_2007. Growth year: 2007. GdA-3845	$\Delta = 45.8 \pm 3.5\text{‰}$	$\delta^{13}\text{C} = -24.21 \pm 0.06\text{‰}$
Tree Ring LA_2006. Growth year: 2006. GdA-3846	$\Delta = 54.2 \pm 3.4\text{‰}$	$\delta^{13}\text{C} = -23.49 \pm 0\text{‰}$
Tree Ring LA_2005. Growth year: 2005. GdA-3847	$\Delta = 38.8 \pm 2.8\text{‰}$	$\delta^{13}\text{C} = -23.7 \pm 0.1\text{‰}$
Tree Ring LA_2004. Growth year: 2004. GdA-3848	$\Delta = 63.5 \pm 3.5\text{‰}$	$\delta^{13}\text{C} = -23.45 \pm 0.14\text{‰}$
Tree Ring LA_2003. Growth year: 2003. GdA-3849	$\Delta = 52.9 \pm 2.8\text{‰}$	$\delta^{13}\text{C} = -23.6 \pm 0.08\text{‰}$
Tree Ring LA_2002. Growth year: 2002. GdA-3850	$\Delta = 55.2 \pm 2.6\text{‰}$	$\delta^{13}\text{C} = -23.89 \pm 0.03\text{‰}$
Tree Ring LA_2001. Growth year: 2001. GdA-3851	$\Delta = 65.6 \pm 3.1\text{‰}$	$\delta^{13}\text{C} = -24.12 \pm 0.06\text{‰}$
Tree Ring LA_2000. Growth year: 2000. GdA-3852	$\Delta = 69.4 \pm 2.6\text{‰}$	$\delta^{13}\text{C} = -24.07 \pm 0.06\text{‰}$
Tree Ring LA_1999. Growth year: 1999. GdA-4305	$\Delta = 82.4 \pm 3.7\text{‰}$	$\delta^{13}\text{C} = -24.12 \pm 0.06\text{‰}$
Tree Ring LA_1998. Growth year: 1998.		$\delta^{13}\text{C} = -24.22 \pm 0.08\text{‰}$
Tree Ring LA_1997. Growth year: 1997.		$\delta^{13}\text{C} = -23.97 \pm 0.07\text{‰}$
Tree Ring LA_1996. Growth year: 1996.		$\delta^{13}\text{C} = -24.27 \pm 0.2\text{‰}$
Tree Ring LA_1995. Growth year: 1995. GdA-4304	$\Delta = 110.3 \pm 3.3\text{‰}$	$\delta^{13}\text{C} = -24.12 \pm 0.06\text{‰}$
Tree Ring LA_1994. Growth year: 1994.		$\delta^{13}\text{C} = -23.53 \pm 0.07\text{‰}$
Tree Ring LA_1993. Growth year: 1993.		$\delta^{13}\text{C} = -23.52 \pm 0.09\text{‰}$
Tree Ring LA_1992. Growth year: 1992.		$\delta^{13}\text{C} = -23.39 \pm 0.11\text{‰}$
Tree Ring LA_1991. Growth year: 1991.		$\delta^{13}\text{C} = -23.59 \pm 0.01\text{‰}$
Tree Ring LA_1990. Growth year: 1990. GdA-4303	$\Delta = 142.3 \pm 3.6\text{‰}$	$\delta^{13}\text{C} = -23.59 \pm 0.04\text{‰}$
Tree Ring LA_1989. Growth year: 1989.		$\delta^{13}\text{C} = -23.88 \pm 0.17\text{‰}$
Tree Ring LA_1988. Growth year: 1988.		$\delta^{13}\text{C} = -23.72 \pm 0.07\text{‰}$
Tree Ring LA_1987. Growth year: 1987.		$\delta^{13}\text{C} = -23.76 \pm 0.11\text{‰}$
Tree Ring LA_1986. Growth year: 1986. GdA-4302	$\Delta = 187.2 \pm 3.3\text{‰}$	$\delta^{13}\text{C} = -24.16 \pm 0.03\text{‰}$
Tree Ring LA_1985. Growth year: 1985. GdA-4301	$\Delta = 197.3 \pm 3.2\text{‰}$	$\delta^{13}\text{C} = -23.8 \pm 0.06\text{‰}$
Tree Ring LA_1984. Growth year: 1984.		$\delta^{13}\text{C} = -23.62 \pm 0.11\text{‰}$
Tree Ring LA_1983. Growth year: 1983.		$\delta^{13}\text{C} = -23.11 \pm 0.05\text{‰}$
Tree Ring LA_1982. Growth year: 1982.		$\delta^{13}\text{C} = -23.7 \pm 0.09\text{‰}$
Tree Ring LA_1981. Growth year: 1981.		$\delta^{13}\text{C} = -24.16 \pm 0.14\text{‰}$
Tree Ring LA_1980. Growth year: 1980. GdA-4300	$\Delta = 258.5 \pm 3.3\text{‰}$	$\delta^{13}\text{C} = -24.41 \pm 0\text{‰}$
Tree Ring LA_1979. Growth year: 1979.		$\delta^{13}\text{C} = -24.13 \pm 0.06\text{‰}$
Tree Ring LA_1978. Growth year: 1978.		$\delta^{13}\text{C} = -24.13 \pm 0.09\text{‰}$
Tree Ring LA_1977. Growth year: 1977.		$\delta^{13}\text{C} = -23.68 \pm 0.16\text{‰}$
Tree Ring LA_1976. Growth year: 1976.		$\delta^{13}\text{C} = -23.51 \pm 0.14\text{‰}$
Tree Ring LA_1975. Growth year: 1975. GdA-4299	$\Delta = 375.9 \pm 3.5\text{‰}$	$\delta^{13}\text{C} = -23.63 \pm 0.09\text{‰}$

Table 4 Tree-ring samples collected near Olesno (50°48'N,18°23'E) from *Pinus sylvestris* L.

Sample details	Δ data	$\delta^{13}\text{C}$ data
Tree Ring OE_2012. Growth year: 2012. GdA-3853	$\Delta = 33.6 \pm 2.9\text{‰}$	$\delta^{13}\text{C} = -24.39 \pm 0.03\text{‰}$
Tree Ring OE_2011. Growth year: 2011. GdA-3854	$\Delta = 25.7 \pm 3.1\text{‰}$	$\delta^{13}\text{C} = -24.49 \pm 0.02\text{‰}$
Tree Ring OE_2010. Growth year: 2010. GdA-3855	$\Delta = 46.5 \pm 3.1\text{‰}$	$\delta^{13}\text{C} = -25.12 \pm 0.12\text{‰}$
Tree Ring OE_2009. Growth year: 2009. GdA-3856	$\Delta = 14.5 \pm 3.2\text{‰}$	$\delta^{13}\text{C} = -24.54 \pm 0.02\text{‰}$
Tree Ring OE_2008. Growth year: 2008. GdA-3857	$\Delta = 46.6 \pm 2.7\text{‰}$	$\delta^{13}\text{C} = -24.82 \pm 0.22\text{‰}$
Tree Ring OE_2007. Growth year: 2007. GdA-3858	$\Delta = 49.2 \pm 2.9\text{‰}$	$\delta^{13}\text{C} = -24.2 \pm 0.01\text{‰}$
Tree Ring OE_2006. Growth year: 2006. GdA-3859	$\Delta = 47.8 \pm 2.7\text{‰}$	$\delta^{13}\text{C} = -23.97 \pm 0.11\text{‰}$
Tree Ring OE_2005. Growth year: 2005. GdA-3860	$\Delta = 66.5 \pm 3.2\text{‰}$	$\delta^{13}\text{C} = -23.96 \pm 0.07\text{‰}$
Tree Ring OE_2004. Growth year: 2004. GdA-3861	$\Delta = 59 \pm 2.8\text{‰}$	$\delta^{13}\text{C} = -23.89 \pm 0.08\text{‰}$
Tree Ring OE_2003. Growth year: 2003. GdA-3862	$\Delta = 70.2 \pm 2.8\text{‰}$	$\delta^{13}\text{C} = -23.6 \pm 0.02\text{‰}$
Tree Ring OE_2002. Growth year: 2002. GdA-3863	$\Delta = 63.6 \pm 2.9\text{‰}$	$\delta^{13}\text{C} = -24.11 \pm 0.18\text{‰}$
Tree Ring OE_2001. Growth year: 2001. GdA-3864	$\Delta = 56.9 \pm 3\text{‰}$	$\delta^{13}\text{C} = -24.55 \pm 0.07\text{‰}$
Tree Ring OE_2000. Growth year: 2000. GdA-3865	$\Delta = 86.3 \pm 3.3\text{‰}$	$\delta^{13}\text{C} = -24.11 \pm 0.01\text{‰}$
Tree Ring OE_1999. Growth year: 1999.		$\delta^{13}\text{C} = -24.09 \pm 0.09\text{‰}$
Tree Ring OE_1998. Growth year: 1998.		$\delta^{13}\text{C} = -24.45 \pm 0.03\text{‰}$
Tree Ring OE_1997. Growth year: 1997.		$\delta^{13}\text{C} = -23.98 \pm 0.07\text{‰}$
Tree Ring OE_1996. Growth year: 1996.		$\delta^{13}\text{C} = -24.36 \pm 0.03\text{‰}$
Tree Ring OE_1995. Growth year: 1995. GdA-4298	$\Delta = 115.1 \pm 3\text{‰}$	$\delta^{13}\text{C} = -24.19 \pm 0.26\text{‰}$
Tree Ring OE_1994. Growth year: 1994.		$\delta^{13}\text{C} = -23.87 \pm 0.02\text{‰}$
Tree Ring OE_1993. Growth year: 1993.		$\delta^{13}\text{C} = -24 \pm 0.11\text{‰}$
Tree Ring OE_1992. Growth year: 1992.		$\delta^{13}\text{C} = -23.51 \pm 0.09\text{‰}$
Tree Ring OE_1991. Growth year: 1991.		$\delta^{13}\text{C} = -23.9 \pm 0.19\text{‰}$
Tree Ring OE_1990. Growth year: 1990. GdA-4297	$\Delta = 156.2 \pm 3.4\text{‰}$	$\delta^{13}\text{C} = -23.71 \pm 0.11\text{‰}$
Tree Ring OE_1989. Growth year: 1989.		$\delta^{13}\text{C} = -23.71 \pm 0.1\text{‰}$
Tree Ring OE_1988. Growth year: 1988.		$\delta^{13}\text{C} = -24.03 \pm 0.09\text{‰}$
Tree Ring OE_1987. Growth year: 1987.		$\delta^{13}\text{C} = -24.27 \pm 0.01\text{‰}$
Tree Ring OE_1986. Growth year: 1986. GdA-4296	$\Delta = 192.3 \pm 3.5\text{‰}$	$\delta^{13}\text{C} = -23.9 \pm 0.05\text{‰}$
Tree Ring OE_1985. Growth year: 1985. GdA-4295	$\Delta = 204.4 \pm 3.5\text{‰}$	$\delta^{13}\text{C} = -23.9 \pm 0.05\text{‰}$
Tree Ring OE_1984. Growth year: 1984.		$\delta^{13}\text{C} = -24.11 \pm 0.01\text{‰}$
Tree Ring OE_1983. Growth year: 1983.		$\delta^{13}\text{C} = -23.68 \pm 0.11\text{‰}$
Tree Ring OE_1982. Growth year: 1982.		$\delta^{13}\text{C} = -23.51 \pm 0.01\text{‰}$
Tree Ring OE_1981. Growth year: 1981.		$\delta^{13}\text{C} = -24.18 \pm 0.24\text{‰}$
Tree Ring OE_1980. Growth year: 1980. GdA-4294	$\Delta = 274.7 \pm 3.7\text{‰}$	$\delta^{13}\text{C} = -24.08 \pm 0.41\text{‰}$
Tree Ring OE_1979. Growth year: 1979.		$\delta^{13}\text{C} = -23.89 \pm 0.24\text{‰}$
Tree Ring OE_1978. Growth year: 1978.		$\delta^{13}\text{C} = -23.78 \pm 0.05\text{‰}$
Tree Ring OE_1977. Growth year: 1977.		$\delta^{13}\text{C} = -24.11 \pm 0.12\text{‰}$
Tree Ring OE_1976. Growth year: 1976.		$\delta^{13}\text{C} = -23.77 \pm 0.04\text{‰}$
Tree Ring OE_1975. Growth year: 1975. GdA-4293	$\Delta = 380.1 \pm 3.5\text{‰}$	$\delta^{13}\text{C} = -23.67 \pm 0.01\text{‰}$