**Figure E1:** $^{29}$Si/$^{91}$Zr data acquired by LA-ICP(Q)MS of NIST SRM610 and 91500 & Plešovice zircons using He + H$_2$O or O$_2$ carrier gases at a glance. Panel (a): $^{29}$Si/$^{91}$Zr mean intensity ratios averaged over an acquisition timeframe of 53 s. Panel (b): Slopes $b$ of linear regression curves calculated from $^{29}$Si/$^{91}$Zr point-by-point signal ratios according to expression (1). Panel (c): Intercepts $a$ of linear regression curves calculated from $^{29}$Si/$^{91}$Zr point-by-point signal ratios according to expression (1). All data points represent the mean of 3 to 12 measurements and error bars refer to the 95% confidence interval of the mean. This figure is organized as follows: Each of the panels (a), (b), and (c) contains three subsets of plots which are arranged pairwise referring to one sample-carrier gas combination. These subsets are, furthermore, consistently scaled for better comparability. For example, mean $^{29}$Si/$^{91}$Zr ratios determined for NIST SRM610 are shown in panel (a) top left while corresponding intercepts are displayed in panel (c) top right. Slopes of $^{29}$Si/$^{91}$Zr ratios vs. time shown in panel (b) were equally scaled throughout all subsets to allow conclusion on the degree of down-hole fractionation in dependence on the material.
Figure E2: $^{238}\text{U}/^{232}\text{Th}$ data acquired by LA-ICP(Q)MS of NIST SRM610 and 91500 & Plešovice zircons using He + H$_2$O or O$_2$ carrier gases at a glance. Panel (a): $^{238}\text{U}/^{232}\text{Th}$ mean intensity ratios averaged over an acquisition timeframe of 53 s. Panel (b): Slopes b of linear regression curves calculated from $^{238}\text{U}/^{232}\text{Th}$ point-by-point signal ratios according to expression (1). Panel (c): Intercepts a of linear regression curves calculated from $^{238}\text{U}/^{232}\text{Th}$ point-by-point signal ratios according to expression (1).

All data points represent the mean of 3 to 12 measurements and error bars refer to the 95% confidence interval of the mean. This figure is organized as follows: Each of the panels (a), (b), and (c) contains three subsets of plots which are arranged pairwise referring to one sample-carrier gas combination. These subsets are, furthermore, consistently scaled for better comparability. For example, mean $^{238}\text{U}/^{232}\text{Th}$ ratios determined for NIST SRM610 are shown in panel (a) top left while corresponding intercepts are displayed in panel (c) top right. Slopes of $^{238}\text{U}/^{232}\text{Th}$ ratios vs. time shown in panel (b) were equally scaled throughout all subsets to allow conclusion on the degree of down-hole fractionation in dependence on the material.
Figure E3: $^{248}\text{ThO}/^{232}\text{Th}$ data acquired by LA-ICP(Q)MS of NIST SRM610 and 91500 & Plešovice zircons using He + H$_2$O or O$_2$ carrier gases at a glance. Panel (a): $^{248}\text{ThO}/^{232}\text{Th}$ mean intensity ratios averaged over an acquisition timeframe of 53 s. Panel (b): Slopes $b$ of linear regression curves calculated from $^{248}\text{ThO}/^{232}\text{Th}$ point-by-point signal ratios according to expression (1). Panel (c): Intercepts $a$ of linear regression curves calculated from $^{248}\text{ThO}/^{232}\text{Th}$ point-by-point signal ratios according to expression (1). All data points represent the mean of 3 to 12 measurements and error bars refer to the 95% confidence interval of the mean. This figure is organized as follows: Each of the panels (a), (b), and (c) contains three subsets of plots which are arranged pairwise referring to one sample-carrier gas combination. These subsets are, furthermore, consistently scaled for better comparability. For example, mean $^{248}\text{ThO}/^{232}\text{Th}$ ratios determined for NIST SRM610 are shown in panel (a) top left while corresponding intercepts are displayed in panel (c) top right. Slopes of $^{248}\text{ThO}/^{232}\text{Th}$ ratios vs. time shown in panel (b) were equally scaled throughout all subsets to allow conclusion on the degree of down-hole fractionation in dependence on the material.