

Structure and Performance in the  
Roman Economy.  
Models, Methods and Case Studies

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## **Preface**

This is the first book published by the research network 'structural Determinants of Economic Performance in the Roman World' (2012-2016), funded by the Research Foundation Flanders (FWO) to stimulate research on Roman economic development. The network's aim is to identify the causes and constraints of economic growth and development in the Roman world. The eight papers we present here explore theories, models and methods that enhance our ability to explain Roman economic performance and offer relevant and original case studies. Seven were discussed at a meeting in Brussels in 2012, generously sponsored as a 'Contactforum' by the Royal Flemish Academy of Belgium for Science and the Arts. The paper by George Grantham was originally discussed at an authors' meeting in Ghent in 2013 for a book on 'Work, Labour and Professions in the Roman World'. The close ties it showed with the papers by Jeroen Poblome and Koenraad Verboven made us suggest the author to publish it here. We are grateful to him for generously accepting this suggestion. The paper by Wim Broekaert was written on invitation to complete the book with a contribution on Social Network Analysis.

Thanks are due to the Research Foundation Flanders (FWO) and the Royal Flemish Academy of Belgium for Science and the Arts for making this project financially feasible, and to Latomus for accepting to publish this volume in their 'Collection'. Last but not least we wish to thank our editorial assistants Kasey Reed, Luka Tjampens and Nicolas Solonakis for their help in preparing the manuscript.

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Anne KOLB

## Epigraphy as a Source on Ancient Technology\*

Economic productivity in antiquity was already substantially based on highly sophisticated procedures in the fields of agriculture, crafts, trade, building, transport as well as finance. With respect to technological progress, the thesis of stagnation caused by a lack of rationalisation or empirical orientation, postulated by Finley and others, is outdated.<sup>1</sup> Studies in the history of technology have shown that important technical achievements were not only used for military purposes, or in building or for water lifting<sup>2</sup> but also in many other areas, as, for instance, in power engineering.<sup>3</sup>

\*This article is a revised version of my paper *Technik und Innovation des Imperium Romanum im Spiegel der epigraphischen Denkmäler* in B. ONKEN / D. RHODE (eds.), *In omni historia curiosus. Studien zur Geschichte von der Antike bis zur Neuzeit. Festschrift für Helmuth Schneider zum 65. Geburtstag*, Wiesbaden, 2011, p. 31-42, I thank Benjamin Hartmann (Zürich) for the translation.

<sup>1</sup> M.I. FINLEY, *The Ancient Economy. Updated with a New Foreword by Ian Morris*. Berkeley, 1999; lately on the broader discussion and the role of epigraphy J. EDMONDSON, *Economic Life in the Roman Empire* in C. BRUUN / J. EDMONDSON (eds.), *Oxford Handbook of Roman Epigraphy*, Oxford, 2014, p. 671-695; on ancient technology and its research B. MEISSNER, *Die antike Technik in der althistorischen Forschung* in W. KÖNIG / H. SCHNEIDER (eds.), *Die technikhistorische Forschung in Deutschland von 1800 bis zur Gegenwart*, Kassel, 2007, p. 163-188; H. SCHNEIDER, *Die antike Technik in der deutschen Archäologie nach 1945* in *ibid.*, p. 191-205; J. P. OLESON, (ed.), *The Oxford Handbook of Engineering and Technology in the Classical World*, Oxford, 2008.

<sup>2</sup> This limitation is still in J. P. OLESON, *Greek and Roman Water-lifting Devices*, Dordrecht, 1984.

<sup>3</sup> For the dissemination of watermills see W. PLEKET, *Greek Epigraphy and Comparative Ancient History: Two Case Studies* in *EA* 12, 1988, p. 25-38 (esp. p. 26-28); on the same topic and on further technologies see A. WILSON, *Machines, Power and the Ancient Economy* in *JRS* 92, 2002, p. 1-32; Ö. WIKANDER, *Sources of Energy and Exploitation of Power* in J. P. OLESON (ed.), *The Oxford Handbook of Engineering and Technology in the Classical World*, Oxford, 2008, p. 136-157; M. MALOUTA / A. WILSON, *Mechanical Irrigation. Water-Lifting Devices in the Archaeological Evidence and in the Egyptian Papyri* in A. BOWMAN / A. WILSON (eds.), *The Roman Agricultural Economy. Organization, Investment, and Production*, Oxford, 2013, p. 273-305. See also above the

Roman technologies and innovations are documented in various literary and material sources. The archaeological record and specialist literature are of special importance as they illustrate or—in the case of archaeological artefacts—even directly hand down the ancient state of knowledge and the practices associated with it, helping us to understand and reconstruct them.<sup>4</sup>

Inscriptions, however, have only rarely been studied in this context. This may be due to the fact that at first sight they either seem to be completely missing or provide only scarce and rudimentary information. By and large, scholars have only taken into consideration three longer inscriptions.<sup>5</sup> Two of these—the *lex metallis dicta* and the *lex territorio metalli Vipascensis dicta* (end of 1<sup>st</sup> / beginning of 2<sup>nd</sup> c.)—concern operating regulations of the mining district of Vipasca in modern southern Portugal.<sup>6</sup> A third and singular inscription, found in the North African city of Lambaesis, gives a detailed account of the problematic tunnel construction of an aqueduct that was undertaken around the middle of the 2<sup>nd</sup> century in Saldæ (modern Bejaia in Algeria).<sup>7</sup>

This very limited yield of inscriptions containing references to technological achievements and innovations inevitably leads to the question of the representativity of the epigraphic evidence. The aim of this paper, therefore, is to analyse specific texts that provide information about techniques and technologies

contribution by Marzano.

<sup>4</sup> For the sources see S. CUOMO, *Ancient Written Sources* in J. P. OLESON (ed.), *The Oxford Handbook of Engineering and Technology in the Classical World*, Oxford, 2008, p. 15-34 (esp. p. 28); B. CECH, *Technik in der Antike*, Darmstadt, 2010, p. 17.

<sup>5</sup> See especially H. SCHNEIDER, *Die Gaben des Prometheus. Technik im antiken Mittelmeerraum zwischen 750 v. Chr. und 500 n. Chr.* in W. KÖNIG (ed.), *Propyläen Technikgeschichte*, Berlin, 1990, p. 19-313 (esp. 226, 228, 288); H. SCHNEIDER, *Einführung in die antike Technikgeschichte*, Darmstadt, 1992, p. 76-77, 87, 192; H. SCHNEIDER, *Geschichte der antiken Technik*, München, 2007, p. 93, 116; cf. the literature in notes 6 and 7.

<sup>6</sup> *CIL* II, 5181 (*Metallum Vipascense*, Lusitania) = C. DOMERGUE, *La mine antique d'Aljustrel (Portugal) et les tables de bronze de Vipasca*, Paris, 1983, p. 114-121; edited individually: a) *Lex metallis dicta*: FIRA I<sup>2</sup> 104 = D. FLACH, *Die Bergwerksordnungen von Vipasca* in *Chiron* 9, 1979, p. 399-448 (esp. p. 399-407); b) *Lex metalli Vipascensis*: FIRA I<sup>2</sup> 105 = FLACH, *ibid.*, p. 407-413; cf. S. LAZZARINI, *Lex metallis dicta. Studi sulla seconda tavola di Vipasca*, Roma, 2001; for questions about the administration and the scope of the regulations found in the two inscriptions see P. EICH, *Zur Metamorphose des politischen Systems in der römischen Kaiserzeit: die Entstehung einer "personalen Bürokratie" im langen dritten Jahrhundert*, Berlin, 2005, p. 315, 322-323, concerning the dating of the inscriptions 322 note 2; A. M. HIRT, *Imperial Mines and Quarries in the Roman World. Organizational Aspects 27 BC-AD 235*, Oxford, 2010, p. 2-4, 261-269 and *passim*.

<sup>7</sup> *CIL* VIII, 2728 = 18122 = *ILS* 5795 (Lambaesis, Numidia); thereto most recently K. GREWE, *Tunnels and Canals* in J. P. OLESON (ed.), *The Oxford Handbook of Engineering and Technology in the Classical World*, Oxford, 2008, p. 319-336 (esp. 329-333); S. CUOMO, *A Roman Engineer's Tales* in *JRS* 101, 2011, p. 1-23.

of any kind and that refer to details about technological methods. We will question the intention and context of these sources. The documents will be presented according to the conventional generic classification of epigraphic sources. Finally, we will briefly ask whether these and other sources provide information about the economic purposes and consequences of technological achievements and innovations.

### 1 Public records

As already mentioned, the two texts from Vipasca (end of 1<sup>st</sup> / beginning of 2<sup>nd</sup> c.) provide information about the operating regulations of the local silver mines. They describe various aspects of mining technology and regulations, particularly regarding security measures. In the Roman west such *leges* were, just like other important and long-standing rulings, recorded on bronze tablets (cf. particularly the town statutes). They were intended to communicate provisions of the Roman administration, primarily trying to guarantee a smooth organisation (including the social conditions of the local population) and an efficient management.

Two further extraordinary public records explicitly focus on technology in the Roman building trade. These inscriptions cannot be compared to any other document, as they not only record specifics regarding building projects but also technically explain the organisation of the construction works in question. An epigraphic legal document of republican times from Puteoli, the so-called *lex parietis faciundo Puteolana* (105 BC), contains a request to tenders.<sup>8</sup> Besides legal and organisational aspects of the work—such as deadlines, magistrates in charge, salary and the name of the contractor—the document accurately lists the particulars on how to erect the enclosure and the monumental gateway to a sacred precinct, complete with information about measurements, building materials and timber construction technique. Because the initial invitation to bid was issued by the community of Puteoli, the epigraphic publication announcing the completion of the construction works took the form of a deed of foundation. In this way, every single citizen was able to assess the works financed by the community.

The second document describes organisational and technical problems related to the construction of a theatre in Miletus (AD 120) that were solved by the

<sup>8</sup> *CIL* I<sup>2</sup>, 698 = *ILS* 5317; for text, translation, and comprehensive commentary see Th. WIEGAND, *Die puteolanische Bauinschrift sachlich erläutert in Jahrbücher für classische Philologie* Supp. 20, 1894, p. 660-778; most recently with text and a translation J.-M. LASSÈRE, *Manuel d'épigraphie romaine*, Paris, 2005, p. 402-405, nr. 249; cf. for legal aspects J.-J. AUBERT, *En guise d'introduction: contrats publics et cahiers des charges* in J.-J. AUBERT (ed.), *Tâches publiques et entreprise privée dans le monde romain*, Neuchâtel / Genève, 2003, p. 1-25.

consultation of the oracle of Apollo of Didyma. The answer of the god, who was questioned by workers on how to proceed after a change in construction management, is recorded on a limestone block in the theatre.<sup>9</sup> The builders had discontinued work on the arches and cross vaults of the upper ambulatory, possibly because these operations turned out to be more difficult, complex, or dangerous than expected. The oracle resolved the uncertainties and the disputes that had sprung from them. Thus, with the god's assistance, the complex construction works were brought to a successful conclusion. By eventually incorporating the inscription into the building, this fact was made clearly visible to all visitors.

Irrigation techniques are illustrated by a series of other epigraphic documents. These texts record the regulations necessary to define the conditions under which the water could be received, or more specifically used, by residents and others for economic (usually agrarian) purposes. Most commonly, the landowner guaranteed the irrigation by limiting the times at which water could be tapped. The corresponding public documents on stone or bronze were intended to set up the modalities and disclose these to the public.<sup>10</sup>

An official record from Greece contains particularly interesting evidence, revealing objectives of construction engineering as well as economic policy. In a letter dating from AD 125, the emperor Hadrian informed the citizens of the west Boeotian community of Koroneia about his plans to protect the cropland of the Kopais valley from flooding: at his order, the estuarial areas of the rivers were to be regulated while the Kopais valley was to be drained by erecting dams at the banks of the Kephisos, the Herkynna, and other rivers.<sup>11</sup> Furthermore, the

<sup>9</sup> *I. Milet VI 2, 935 = SGO 01/20/01*; cf. M. DONDERER, *Die Architekten der späten römischen Republik und der Kaiserzeit: epigraphische Zeugnisse*, Erlangen, 1996, p. 91-93, 156-158. On the circumstances of the find Th. WIEGAND, *Dritter vorläufiger Bericht über die Ausgrabungen der Königl. Museen zu Milet in Archäologischer Anzeiger* 19, 1904, p. 2-10 states: "beim Eingang in den oberen Umgang auf einem Kalksteinblock an der Südseite des obersten Treppenabsatzes des Westflügels in situ" (p. 8).

<sup>10</sup> *CIL VI, 1261; XIV, 3676; VIII, 4440 = 18587 = ILS 5793; AÉ 2006, 676*; thereto F. BELTRÁN LLORIS, *An Irrigation Decree from Roman Spain: The Lex Rivi Hiberiensis in JRS* 96, 2006, p. 147-197 and ID., *La lex rivi Hiberiensis nel suo contesto. I pagi e l'organizzazione dell'irrigazione in Caesar Augusta* in L. MAGANZANI / C. BUZZACCHI (ed.), *Lex Rivi Hiberiensis. Diritto e tecnica in una comunità di irrigazione della Spagna Romana. Giornate di studio in ricordo di Giorgio Luraschi, Milano 2-3 luglio 2012*, Napolina, 2014, p. 55-73; cf. C. J. BANNON, *Gardens and Neighbors; Private Water Rights in Roman Italy*, Ann Arbor, 2009, p. 76-81, 111-113.

<sup>11</sup> *AÉ 1986, 636a = SEG 32, 460 (Koroneia, Achaia):* Ἀγαθὴ τύχη / Αὐτοκράτωρ Καῖσαρ, θεοῦ Τραϊανοῦ Παρθικοῦ υἱός, θεοῦ Νέρουα υἱωνός, / Τραϊανός Ἀδριανός Σεβαστός, ἀρχιερεὺς μέγιστος, δημαρχικῆς ἐξουσίας / τὸ θ', ὕπατος τὸ γ', Κορωνέων τοῖς ἄρχουσι καὶ τῇ βουλῇ καὶ τῶι // δήμοι vac. Χαίρειν vac. / Ἐκέλευσα γενέσθαι χώματα τῶ Κηφισῶ καὶ τῇ Ἐρκύνῃ καὶ τοῖς ἄλλοις ποταμοῖς καθὼς ἤδη μετ' ἀλλήλων ῥέοντες εἰς τὴν

emperor announced he would deal with the water supply of the city at his own expenses. This imperial letter, announcing new building projects, was designed to warrant flood control as well as to ensure agrarian production, as these measures were vital not only to the population's food supply but ultimately also to the area's tax revenues. While the epigraphic document attests technological achievements, its primary concern nonetheless was of a fiscal and economic nature.

## 2 Funerary, Honorific, and Votive Inscriptions

The already mentioned inscription from the North African city of Lambaesis gives an elaborate account of the cutting of an aqueduct tunnel through a mountain from both ends.<sup>12</sup> The construction works in Saldæ (modern Bejaia in Algeria, middle of 2<sup>nd</sup> c.) were confronted with several problems, described in detail by the leading engineer Lucius Nonius Datus. He describes how the two work units that according to his plans were ordered to channel through the mountain from both ends simultaneously had missed each other at the centre. It was only after his return and through renewed efforts of measurement that the error was corrected and the work could be finished. The inscription seems originally to have belonged to the funerary monument of Lucius Nonius Datus (in the form of an octagonal *cippus*, partly ornamented with images in bas-relief), erected by himself during his lifetime. The inscription served as a medium of self-representation, visualising the accomplishments of the proud architect in the field of surveying engineering.<sup>13</sup>

No other documents describing technological methods in a similarly exhaustive way are known today. However, such testimonia must have been much more frequent than the small number of surviving monuments suggests.<sup>14</sup> Several funerary inscriptions of engineers and craftsmen, especially in the sectors of water

Κωπαΐδα / λίμνην ἐμβάλλουσιν· καὶ γενήσεται τὴν ταχίστην ὡς κατὰ τὰς / ὄχθας ῥέοντες  
μὴ ἐκτρέποντο τοῦ πόρου μήδε, ὡσπερ νῦν, // ἐπικλυζοῖεν τὴν πολλὴν τῆς χώρας τῆς  
ἐργασίμου· Κατάξω / δεῦμεινκαῖῶδωρ· Καὶ τὸ μὲν ἀργύριον δοθήσεται παρ' ἐμοῦ / ἕξ καὶ  
ἡμισυ μυριάδες ὅσου δεήσειν ἔφασκον οἱ τῶν τοιούτων ἐπιστήμονες, ὑμεῖς δὲ ἐλέσθε  
τοὺς ἐπιμελησομέ/νους.

<sup>12</sup> *CIL* VIII, 2728 = 18122 = *ILS* 5795 (Lambaesis, Numidia); see further note 7.

<sup>13</sup> Note the wording in *CIL* VIII, 2728, ll. 54-60: ... *ego qui pri/mus libram feceram / ductum atsignaueram(!) / fieri institueram se/cundum formam quam Petronio Celeri pro(curatori) / dederam opus (!) effectum....*

<sup>14</sup> Cf. the glassmaker in *CIL* XIII, 2000 = *ILS* 7648 (Lugdunum, Gallia Lugdunensis): *D(is) M(anibus) / et memoriae aetern(a)e Iul/i Alexsa(n)dri(!) natione Afri ciui / Carthagine(n)si (h)omini optimo opif/ici artis utriae ....*

engineering<sup>15</sup> and the building trade,<sup>16</sup> display a comparable self-confident demeanour. Nevertheless, they mention only a few details concerning the technical realisation of the projects involved.

Such displays of praise for and pride in extraordinary technological achievements are also found in other types of epigraphic texts that were used to represent their authors or other protagonists, such as honorific, panegyric, and votive inscriptions.

A special honorary inscription is found on a well-known monument at the centre of the empire; the inscription on Trajan's column in Rome:

*Romanus / Imp(eratori) ... Neruae / Traiano ... pontif(ici) / maximo ... p(atriciae) / ad ... altitudinis / mons et locus tant[is oper]ibus sit egestus.*<sup>17</sup>

The text on the base of Trajan's column, inaugurated on the 13<sup>th</sup> of May AD 113 as the showpiece of the emperor Trajan's (AD 98-117) *Forum Traiani*, refers to the building operations conducted during the years AD 107 to 112 that prepared the construction of this massive triumphal site—still admired by the emperor Constantius II during his visit to Rome in AD 354 as “a construction unique under the heavens [...] and admirable even in the unanimous opinion of the gods”.<sup>18</sup> Trajan had this imperial forum, which was the last and grandest of the imperial fora of Rome, built from the spoils of his Dacian wars (AD 101-102 and 105-106). The senate and the people of Rome honoured their emperor by donating this honorary monument consisting of a column and a mounted effigy of Trajan. Thus, they not only acknowledged him as a victorious general and extraordinary ruler, but also as a magnificent architect, who had achieved exceptional building feats at the heart of the empire's capital. Indeed, in order to make room for the huge building complex consisting of a square (lined by two galleries with exedrae and a monumental gateway), the Basilica Ulpia as well as two libraries, the ridge between the Quirinal and the Capitol was removed. Huge amounts of soil were

<sup>15</sup> *CIL XII, 722 = ILS 7715* (Arelate, Gallia Narbonensis) *D(is) M(anibus) / Q(uinti) Candi[di] Benigni fab(ri) tig(narii) c(or)p(or)is Ar(elatis) ars cui summa fuit / fabricae, studium doctrin(ae) / pudorque, quem magni / artifices semper dix{s}ere / magistrum. doctior hoc ne/mo fuit, potuit quem uinc/ere nemo, organa qui nosse/t facere aquarum aut duce/re cursum hic couiua (!) fui/t dulcis, nosset qui pasce/re amicos, ingenio studio / docilis animoque benignus. Candidia Quintina / patri dulcissimo et Val(eria) / Maximina(!) coniugi kar(issimo).*

<sup>16</sup> See the two funerary poems for builders in *IK XXXIV, 468* (Mylasa, Asia) and in E. BERNAND, *Inscriptions métriques de l'Égypte gréco-romaine; Recherches sur la poésie épigrammatique des Grecs en Égypte*, Paris, 1969, p. 128-133, no. 23; cf. DONDERER, *Architekten* [n. 9], p. 91-93, 110-112.

<sup>17</sup> *CIL VI, 960 = ILS 294*; further A. KOLB / F. FUGMANN, *Tod in Rom. Grabinschriften als Spiegel römischen Lebens*, Mainz 2008, p. 36-40.

<sup>18</sup> Ammianus XVI, 10, 15: (...) *singularem sub omni caelo structuram, ut opinamur, etiam numinum assensione mirabilem* (...) (Transl. J. C. Rolfe).

moved, according to the inscription amounting to the height of the column of 100 Roman feet (29.78 m). Thus, this honorary inscription for the emperor Trajan constitutes important evidence of Roman engineering as the monument explicitly documents the technological effort needed to build the forum and at the same time commemorates this extraordinary achievement of Roman engineering.

An inscription from Lycia (AD 134) is quite remarkable too. It contains the self-praise of two woodworkers who apparently were the first to transport cedar wood of the highest quality, presumably for use as building material, out of a deep and inaccessible ravine.<sup>19</sup> Apart from solving the logistical problems, the innovation of the two specialists primarily consisted of cutting up the logs already at the felling site, i.e. in the ravine itself, making it easier to transport the timber to the collecting point, which must have been situated near the road. The inscription is recorded on a plain limestone block (in a *tabula ansata*). Unfortunately, its original architectural context is lost. As the inscription was found close to the Claudian road from Neisa to Choma, the original location of the monument might have to be sought in its proximity, e.g. in a possible terminal or storage location. It is unusual that the inscription is not formulated as an honorary or votive inscription but as outright evidence for the achievement of the woodworkers. One could perhaps assume that the woodworkers ascribed their success to divine help and subsequently erected a votive monument. Accordingly, the block, if it did not serve as a basis for a statue of a deity, might originally have belonged to such a monument, for example as an element of a small cultic building.

While donors usually offered such votive gifts in recognition of the divine help they experienced, other votive inscriptions display the additional purpose to reveal the labours and expenditures that were needed to accomplish the donation. Information about technology is usually either wholly absent or only mentioned briefly and summarily.<sup>20</sup> The texts only offered more technological detail if

<sup>19</sup> SEG 57, 1667 = S. ŞAHİN, *Zwei Holzfäller und der Wald in der Kartapis bei Neisa in Gephyra* 4, 2007, p. 37-45: Ἐπὶ ἀρχι(ερέως) Κιλόρτου / ἀπὸ τῆς ἐν Καρταπίδι ὕλης οὐδέποτε οὐδεὶς πρῶτα ἐξήγαγε<ν> ἴκρι<α>, ἀλλὰ / μόνοι Ἀρτεμῆς Ἑρμαίου / τοῦ Ἀπολλωνίου (vac.) καὶ / Ἑρμαῖος δις τοῦ Θεοδότου Νεισεῖς ἐπεχείρησαν. / οἱ ἀναγεινώσκοντες / εὐτυχεῖτε.

<sup>20</sup> CIL V, 1863 = ILS 5886 (Iulium Carnicum, Italia): [I(oui) O(ptimo)] M(aximo) / [Triuii Quadri]uii ceterisque dib(us) / aram o[b solutum merit]o sollemne uotum d[ed(it)] / Hermias succesor operis aeterni, / titulum immanem, montem Alpinum / ingentem litteris inscripsit, quot saepe / inuium, commiantium (!) periclitante / popu[l]o, ad pontem transitum non / placuit, curiae et Attio Braetiano / q(uaestore) eorum, uiro ornato, uiam nou(am) / demonstrante Hermia. Multa n[on]n[on] fides operisque paratus una/nimes omnes hanc uiam explicuit; CIL III, \*259 = AE 1955, 119 (Cetium, Noricum): D(eo) Neptuno / [aq]uarum / [po]tenti / [ob i]nductum / [in] Tragisa(mum) / [riu]um / [---] Aur(elius) / [---]lius / [u(ir) p(er)fectissimus] a(gens) u(ices) p(raesidis) / [u(otum) s(oluit)] l(ibens) l(aetus) m(erito).

special circumstances warranted such, as one inscription from North Africa shows: *Caelesti Aug(ustae) Granianae sacr[um] / Voltius Senecio templum ui fluminis ereptum transtulit et a solo fecit idemque dedica[uit]*.<sup>21</sup> The sanctuary of a popular local sky goddess had been carried away by the rising flood waters of a river. Voltius Senecio, an euergetist, took care of disassembling the cult building and re-erecting it at another site. Such actions may have been common in ancient times, although they are not mentioned otherwise.<sup>22</sup>

Further references to difficult or interesting building techniques and facilities can be found in epigraphic epigrams that celebrated especially successful, important, or useful buildings.<sup>23</sup> Some of these texts also focus on the architect or the builder by publicly stating his achievements so that his name might be remembered. A late antique epigram from Adana (first half of 4th c. AD) describes the massively solid reinforcement of a river bank and the related building of a bridge by an architect called Auxentius, whose execution of the construction work is specified by technical details. The quays, which were built on a foundation reinforced by iron dowels and were spanned by an extremely sturdy and wide bridge, were designed to hold back the mostly wintry rip tides of the Saros and prevent it from flooding the surroundings.<sup>24</sup> Whether this poem for the glory of the architect, written on a

<sup>21</sup> *IL Afr.* 345 (Haut Mornag, Africa Proconsularis).

<sup>22</sup> This inscription once again shows how the genres of votive and building inscriptions overlap if a votive inscription at the same time documents a building measure.

<sup>23</sup> *CIL VIII*, 21081 = *CLE* 276 = S. BUSCH, *Versus Balnearum. Die antike Dichtung über Bäder und Baden im römischen Reich*, Stuttgart, 1999, p. 229-230 (Caesarea, Mauretania): *Vit<r>ea quot longis sunt / tecta excepta columnis / ac docili libra teretem q/uo<t> flexus in arcum est, / marmore quot Pareo uiuunt / spirantia signa aequo[ris] / [e]t uario quot p[ro]fluit unda meatu ---*; *SEG* 36, 1343 (Gadara, Syria): Μηκέτι τάρβος ἔχοιτε λοετροφόρον ἀσαμίνθου / οὐλομένης ἢ μύρια πολλοῖς ἄλγε' ἔθηκεν / [ἄ]νδρας σινομένη κτεινοῦσα τέ πολλάκι παῖδας / [---]ς γὰρ ὑπερθεν ὄλην κατεχώσατο γαίη· / [χώματ]α δὲ στορέσας φιλοπαίγμονα θήκατο χώρον / [πηγὰς τ' ἔκτο]θι δούς τερψίμβροτον ἐλέμεν ὕδωρ; *Fouilles des Xanthos I*, 1958, 110 (Xanthos, Lycia): Ὀνάσανδρος Ὀνασάνδρου τοῦ / Ὀνασά[ν]δρου Ξάνθος ἀρχι[εκτονή]σας / τὸν κα[---]α σὺν τῆ[β]άσει [καὶ τῶ] / ἐπικε[ιμένω] κόσμ[ω ---] / ἐπ' αὐτῶ [---]ιστεμ[---] / εντωμ[---]νρ[---]υθ[---] / μι[---] ἀπ[ο]καθελὼν ἐλκύσας / μετέθηκεν; *SEG* 32, 1502 = *SGO* 21/22/01 (Gadara, Syria): Εὐδοκίας Αὐγούστης / Πολλά μὲν ἐν βιότῳ κ(αὶ) ἀπίρονα θαύματ' ὄπωπα / τίς δέ μιν ἐξερῆσι, πόσα δὲ στόματ', ὧ κλίβαν' ἐσθλέ / σὸν μένος, οὐτιδανὸς γεγαῶς βροτός; Ἀλλὰ σε μᾶλλον / ὠκεανὸν πυρόεντα νέον θέμις ἐστὶ καλεῖσθαι. / Παῖάνα καὶ γενέτην γλυκερῶν δοτῆρα ρεέθρων. / Ἐκ σέο τίκτεται οἶδμα τὸ μυρίον, ἄλλυδις ἄλλη, / ὄπη μὲν ζεῖον, πῆ δ' αὖ κρυερὸν τε μέσον τε. / Τετράδας ἐς πίσυρας κρηνῶν προχέεις σέο κάλλος. // ... / ἄλλα θεὸν κλυτόμητιν ἀείσο[μαι ---] / εἰς εὐεργεσίην μερόπων τε χρ[---].

<sup>24</sup> *CIG III*, 4440 = *IGR III*, 887 = *SGO* 19/14/01 (Adana, Cilicia): ὄντως σῆς ἀρετῆς, Αὐξέντιε, καὶ τότε θαῦμα / δείμασθαι ποταμοῦ χειμερίοισι δρόμοι[ς] / ἄρρηκτον (?) κρηπίδα σιδηροθέτοισι θεμελίοις / ὧν ὑπερ εὐρείην ἐξετάνυσσας ὁδόν, / ἦν πολλοὶ καὶ πρόσθεν ἀπειρήσι νό[οι]ο / Κυδναίων ρεῖθρων τεῦξαν ἀφαιροτέτην. / σοὶ δ' ὑπὲρ ἀνιδίων αἰώνιος ἐρρίζωθαι / καὶ ποταμὸς πλήθω[ν] πρηύτερος τε[λ]έθει, / αὐτὸς τήνδ[ε] γέφυραν ἀνασχόμενος τελέε[σ]α[σθ]αί / ἠγεμόνος π[ε]ιθο[τ]ι τοῦ διασημοτάτου, / ὄφρα

block of stone, originally belonged to an honorary monument, a consecration for a god, or rather to a building inscription cannot be ascertained.

### 3 Building Inscriptions

The mention or description of technological feats of craftsmanship is most common in building inscriptions when difficulties had been encountered with very complex and elaborate constructions. In general, inscriptions that attest the construction of highly engineered facilities such as aqueducts, tunnels, roads, or canals only rarely specify the procedure, working methods, difficult working conditions, or other interesting features. Most inscriptions merely attest the conclusion of the works by adding *f(aciendum) c(urauit)* or similar formulations.<sup>25</sup> Inscriptions with technological details were set up—as is usual for building inscriptions—at the instigation of private builders,<sup>26</sup> municipal magistrates,<sup>27</sup> governors or other representatives of the Roman

σε καὶ μετόπισθεν ἔχοι κλέος ἴσον ἐκείνοις / οἱ Νείλου προχοὰς ζεῦξαν ἀπειρεσίους; cf. DONDERER, *Architekten* [n. 9], p. 94-96.

<sup>25</sup> See e.g. the brief inscription of the formidable tunnel construction by Vespasian and Titus in Cevlik/Seleukia Pieria in modern Turkey: *CIL* III, 6702 = *IGLS* 3/2, 1131: *Diuus Vespasianus / et diuus Titus f(aciendum) c(urauerunt)*.

<sup>26</sup> *CIL* IX, 3018 = *ILS* 5761 (Teate Marrucinorum, Italia): *In honorem domus / Augustae / Dusmia M(arci) f(ilia) Numisilla / nomine suo et L(uci) Trebi Secundi / uiri sui aquam quae a C(aio) Asinio / Gallo perducta interciderat / repetitam a capite adiecta structura / specus et puteorum nouis bracchis / ampliata s(ua) p(ecunia) reduxit; CIL* XII, 2494 = *ILS* 5768 (Marigny-Saint-Marcel, Gallia Narbonensis): *C(aius) Sennius C(ai) f(ilius) Vol(tinia) Sabinus praef(ectus) fabr(um) / balineum campum porticus aquas iusque / earum aquarum tubo ducendarum ita ut recte / perfluere possint uicanis Albimnensibus d(e) s(uo) d(edit)*.

<sup>27</sup> *CIL* X, 6526 = *ILS* 5772 (Cora, Italia): *C(aius) Oppius Verus L(ucius) Turpilius / Priscus f(ilius) IIIuir(i) i(ure) d(icundo) / ex aquam caelestem dilabentem mon/tibus collectam interciso aggere / per formam cur(a) sua factam in pisci/nis repurgatis longo tempore ces/santibus p(ecunia) p(ublica) perduxerunt / et PE[---]AO[---]; CIL* X, 4654 = *ILS* 5779 (Cales, Italia): *Ex s(enatus) c(onsulto) honoris Q(uinti) Paconii Q(uinti) f(ili) / Lepta[e] ergo / lacus fistulaeque con/stitutae substructae quo / commodius in eius domum / aqua pura duceretur quod / is de r(e) p(ublica) saepe numero bene / meritis esset mereretur(ue) / Q(uintus) Paconius Q(uinti) f(ilius) Lept[a] IIIuir / quinquennalis ex s(enatus) c(onsulto) / locauit idemqu[e] probauit*.

administration,<sup>28</sup> or the emperor himself.<sup>29</sup>

A very interesting example in this category is an inscription from the Lycian city of Patara, which attests the construction of an aqueduct commissioned by Vespasian and the innovation triggered by these works:<sup>30</sup>

After the wall of the aqueduct had been destroyed by an earthquake, Emperor Caesar Flavius Vespasianus Augustus had it rebuilt together with the aqueduct made of stone blocks on top of it. In addition, he ordered earthenware pipes of a hand's width for water under pressure to be laid in three rows along the wall. As a result, the flow of the

<sup>28</sup> *CIL VIII*, 2661 (p. 1739) = *ILS 5788* (Lambaesis, Numidia): *Aquam Titulensem quam ante annos / plurimos Lambaesitana ciuitas in/teruerso ductu ui torrentis amiserat / perforato monte instituto etiam a / solo nouo ductu Seuerinius Apronianus u(ir) p(er)fectissimus p(raeses) p(rouinciae) N(umidiae) / pat(ronus) col(oniae) restituit cur(ante) Aelio Rufo u(iro) e(gregio) fl(amine) p(er)p(etuo) cur(atore) r(ei) p(ublicae); ILAlg II, 3596 (Castellum Tidditanorum, Numidia): *Ex i[ndu]lgentia prouidentiaq(ue) / diuina dd. nn. (i.e. dominorum nostrorum duorum) / Imp(eratorum) duorum <<Galli>> et <<Vol[usiani]>> Aug(ustorum) duorum / M(arcus) Cocceius Anicius Faustus Flauianus / consular(is) et XVuir curator / et patronus coloniar(um) Cirt(ensium) / egestis per populum quae uicina / superauerant ruderibus / caesoque ad planitiem qui / nudatus extiterat monte / ad salutem populi aquam / excipi prouidit; cf. the building of a pier and a basin in the harbour of Smyrna commissioned by the governor Venetios, *Anthologia Palatina IX*, 670 = *SOG 05/01/19* (Smyrna, Asia).**

<sup>29</sup> *CIL VI*, 1245 (p. 3125, 3797, 4363) = *ILS 98b* (Roma): *Imp(erator) Caes(ar) M(arcus) Aurelius(!) Antoninus Pius Felix Aug(ustus) Parth(icus) maxim(us) / Bri(annicus) maximus pontifex maximus / aquam Marciam uariis kasibus impeditam purgato fonte excisis et perforatis / montibus restituta forma adquisito etiam fonte nouo Antoniniano / in sacram urbem suam perducendam curauit; CIL X, 6811 = *ILS 489* (Ardea, Italia): *Imp(erator) Caes(ar) [[C(aius) Iulius]] / [[Verus Maximinus]] / Pius Felix Aug(ustus) / pontif(ex) max(imus) Germ(anicus) max(imus) / Dacicus max(imus) Sarm(aticus) max(imus) / trib(unicia) potest(ate) IIII imp(erator) V / co(n)s(ul) proco(n)s(ul) p(ater) p(atriciae) et / [[C(aius) Iulius Verus Ma]]/[ximus nob(ilissimus) Caesar]] / Germ(anicus) max(imus) Dacicus max(imus) / Sarmaticus max(imus) / princeps iuuentutis / litus uicinum uiae Seuerianae / adsiduis maris adluentibus / fluctibus ad labem ruinae / labefactatum aggeribus / marini operis a fundamentis / ut periculum commeantibus / abesset extrui curarunt.**

<sup>30</sup> *SEG 57*, 1673; S. ŞAHİN, *Die Bauinschrift auf dem Druckrohrquädukt von Delikkemer bei Patara* in Ch. SCHULER (ed.), *Griechische Epigraphik in Lykien; Eine Zwischenbilanz*, Wien, 2007, p. 99-109; now also H. İŞKAN-İŞİK / W. ECK / H. ENGELMANN, *Der Leuchtturm von Patara* in *ZPE 164*, 2008, p. 91-121 (esp. p. 116) (with German translation): *Αὐτοκράτωρ Καῖσαρ Φλάβιος Οὐεσπασιανὸς Σεβαστὸς / τὸ τοῦ ὑδραγωγίου ἀνάλημμα συμπεσὸν σειμοῖς ἐκ θεμελίων ἀποκατέστησε σὺν / τοῖς ἐπ' αὐτῷ λιθίνους ἐκ τετραπέδου λίθου σωλῆσι προστεθέντος καὶ ἐτέρου παρὰ τὸ / ἀνάλημμα θλειμματικοῦ ὑδραγωγίου διὰ τριστίχων σωλῆνων ὀστρακινῶν παλαιστ/αίων ὥστε δυεῖν ὄντων εἰ θάτερον ἐπισκευῆς δεηθεῖη, μὴ ἐνποδίζεσθαι τὸν δρόμον / ἀδιαλείπτου μενούσης τῆς χρήσεως...; relevance and context discussed by Ch. SCHULER, *Fernwasserleitungen und römische Administration im griechischen Osten* in KOLB, *Infrastruktur* [n. 9], p. 103-120.*

watercourse is not hindered when the pipes need maintenance and the usage is not interrupted because there now are two channels.

This text not only documents the completion of the building or repair work, but points also to a technological achievement of the new construction: next to the stone aqueduct a second supply channel was constructed out of earthenware pipes in order to ensure the water supply of the population of Patara during the frequent cleaning and overhaul periods. By recording the precise technical execution and the design of the water supply in Patara as well as its novelties, the inscription constitutes an important document in the history of technology. Yet, this inscription with its extensive account and mention of innovation makes a singular appearance in its genre, as building inscriptions are usually only interested in the builder, the building as such and the completion of it, while information about building methods is either completely lacking or is only given briefly and summarily.

The biggest group of building inscriptions that provide information on building techniques consists of documents about road building. This is not surprising as questions of transportation infrastructure were a domain of particular interest to the emperors. Indeed, good transport connections between cities and the dense network of roads and waterways throughout the empire—made possible by the *Pax Romana* due to imperial protection—were not only important to imperial policy but above all to the administration and the economy. In order to travel and conduct transport efficiently—primarily on behalf of the state—the main links had to be open to traffic. Difficult terrain often demanded technically complex operations, which, if successful, were documented by inscriptions. Particular works consisted of the removal and the intersection of mountains and rocks, often expressed in inscriptions with established phraseology like *montibus caesis*.<sup>31</sup> The

<sup>31</sup> *CIL* III, 227 = 12118 = 14177, 11 = *IK* LV, 135 (Gülek Bogazi, Cilicia): *Imp(erator) Ca(e)sar Marcus Au(re)lius [[Antoninus pi]]us / felix inuictus Augu(stus) montibus caesi[s] / uiam latiore[m] fecit.* ὄροι Κιλίκων; *CIL* III, 206 (p. 973) = *ILS* 5865 (Berytus, Syria): *Imp(erator) Caes(ar) M(arcus) Aurelius / Antoninus Pius Felix Augustus / Part(hicus) max(imus) Brit(annicus) max(imus) Germ(anicus) maximus / pontifex maximus / montibus imminentibus / Lyco flumini caesis uiam delatauit / per [[leg(ionem) III Gallicam]] / Antoninianam suam;* *CIL* III, 199 (p. 1228) = *ILS* 5864 (Suq Wadi Barada, Syria): *Imp(erator) Caes(ar) M(arcus) Aurel(ius) Antoninus / Aug(ustus) Armeniacus et / Imp(erator) Caes(ar) L(ucius) Aurel(ius) Verus Aug(ustus) Ar(meni)acus uiam fluminis / ui abruptam interciso / monte restituerunt per / Iul(ium) Verum leg(atum) pr(o) pr(aetore) prouinc(iae) / Syr(iae) et amicum suum / inpendiis Abilenorum;* *CIL* III, 6983 = *ILS* 5883 = *IGR* III, 83 = Ch. MAREK, *Stadt, Ära und Territorium*, Tübingen, 1993, p. 158, no. 1c (Amastris, Pontus et Bithynia): *Pro pace Au(gusti) in honorem Ti(beri) Claudi / Germanici [Caesaris Aug(usti)] Diui Aug(usti) perpetuus sacer/dos C(aius) Iulius [Aquila pr]aef(ectus) fabr(um) bis in aerar(ium) delatus / a co(n)s(ule) A(ulo) Gabin[i]o [Secundo] TaJuro Statilio Coruino mon/tem cecidit e[st] uiam ---]essionem d(e) s(ua) p(ecuni) f(ecit) / Ὑπὲρ τῆς Σεβα[στῆς] εἰρήνης εἰς τὴν τεμῆν Τιβερίου Κλαυδίου Γερμαν[ικοῦ] Σεβαστοῦ,*

crossing of great rivers by bridges was also important—a technological achievement that was also commemorated by epigraphic monuments.<sup>32</sup>

Epigraphic documents of this type are often inscribed on milestones. These are to be counted among the genre of building inscriptions, as in many cases they attest the construction of new roads.<sup>33</sup> As indicators of distance, put up at every mile along the *viae publicae*, they are a mass phenomenon. Besides indicating places and distances, the texts on milestones first and foremost served the representation or reverence of the emperor, which found expression in the detailed forms of address and honorific titles. By adding information on the particularities of important technological achievements of road, bridge, or tunnel construction, the epigraphic monuments increased their praise for the emperor.<sup>34</sup> Overcoming the forces of nature emphasised the encompassing authority and expertise of the emperor, which is repeatedly underlined by the wording and rhetoric of such inscriptions.<sup>35</sup>

τοῦ ἐποθρανίου θεοῦ / Σεβαστοῦ ἀρχ[ιερεὺς Γάιος] Ἰούλιος Ἀκυῖλας, ἔπαρχος / δις εἰς τὸ αἰρ[ῆριον φερόμενος] ὑπὸ ὑπάτων Ὠλοῦ Γαβεινίου Σεκο[ύνδου, Ταύρου Στα]τειλίου Κοροῦνιου τὸν λόφον / κόψας τὴν ὁδ[ὸν καὶ τὸ βάθρον?] ἐκ τῶν ἰδίων ὑπαρχόντων / ἐποίησεν; *CIL* III, 1699 = 8267 = *ILS* 5863 = *ILJug* I, 63 (Ogradina, Moesia superior):

*Imp(erator) Caesar diui Neruae filius) / Nerua Traianus Aug(ustus) Germ(anicus) / pontif(ex) maximus trib(unicia) pot(estate) IIII / pater patriae co(n)s(ul) III / montibus excisi[s] anco[ni]bus / sublat[i]s uia[m r]e[ffecit].*

<sup>32</sup> *CIL* III, 467 = *IK* LIII, 56 (Ilium, Asia): *Imperator Caesar / Mar(cus) Aur(elius) Antoninus / Pius Felix Part(h)icus / maximus Germanicus maximus / trib(unicia) p(otestate) I imp(erator) XV(!) co(n)s(ul) III / prouinciam Asiam / per uiam et flumina / pontibus subiugauit // Imp(eratore) Caesar(e) Aug(usto) / Diocletiano regnante.* For late antiquity see the building of the Sangarios bridge by Justinian, attested in the *Anthologia Graeca* IX, 641 = *SGO* 09/06/04 (Nikomedia, Pontus et Bithynia): Καὶ σὺ μεθ' Ἑσπερίην ὑσαύχενα καὶ μετὰ Μήδων / ἔθνεα καὶ πᾶσαν βαρβαρικὴν ἀγέλην, / Σαγγάριε, κρατερα ἦσι ῥοὰς ἀψῖσι πεδηθεῖς / οὕτω ἐδουλώθης κοιρανικῇ παλάμῃ. / ὁ πρὶν δὲ σκαφέεσσιν ἀνέμβατος, ὁ πρὶν ἀτειρῆς / κείσαι λαϊνὴν σφιγκτὸς ἀλυκτοπέδη.

<sup>33</sup> For the topic see A. KOLB, *Communications and Mobility in the Roman Empire* in BRUUN / EDMONDSON, *Oxford Handbook Epigraphy* [n. 1], p. 649-670, esp. 654-660.

<sup>34</sup> *IK* LV, 132 (Tyana, Cappadocia): *[Imp(erator) Caes(ar)] / [M(arcus) Aurelius Seuerus Antoninus] / [Pius Feli]x [C] A[ugustus Parth(icus) max(imus)] / [Brit(annicus) m]ax(imus) Ger[m(anicus) max(imus)] pontif(ex) / [max(imus) tr]ib(unicia) potest(ate) XX imp(erator) III co(n)s(ul) IIII / [proco(n)]s(ul) p(ater) p(atriciae) uiam Tauri uetustate / [con]l[apsam con]planatis monti[bus e]t c[a]esis rupibus ac dilata/[tis i]tineribus cum pontibus / institutis restituit / a Pylas (!) m(ilia) p(assuum) XV ...; *CIL* II, 4911 = J. LOSTAL PROS, *Los miliarios de la provincia Tarraconense*, Zaragoza, 1992, p. 225-226, no. 277 (Siresa, Hispania citerior): *Iussu domini et princip[is nostri] / Magni Maximi uicto[ri]osissimi / semper Augusti / Antonius Maximin[us] -- / noua[e] prouinciae Ma[ximae] / primus consularis e[st] antea] / praeses uiam ad fa[uces] / rupibus famosam ia[m fluui] / alibus aquis peruam [---] / conplanau[is] solo paca[to] / perdomito auerso fl[umine] / inundationes soliti[s] ---].**

<sup>35</sup> See e.g. *CIL* III, 467 = *IK* LIII, 56 (Ilium, Asia) above note 32: *prouinciam Asiam / per uiam et flumina / pontibus subiugauit*; *SGO* 09/06/04 (Nikomedia, Bithynia) above n. 32.

Moreover, an important part of Roman transportation infrastructure consisted of canals. These were dug in order to ease the use of specific routes or to shorten certain routes and thus to improve the accessibility of important centres.<sup>36</sup> However, only very few inscriptions testify to their construction or maintenance.<sup>37</sup> Information about the technical design or the characteristics of building measures are even rarer. An exception in this respect is the inscription found at the southern end of the canal built by Trajan at the Danube near the ‘Iron Gates’ (Djerdap).<sup>38</sup> Trajan’s artificial waterway allowed ships to bypass the barely navigable rapids (*cataractae*) at present-day Sip. Further documents stem from the Egyptian Nile delta, attesting technically difficult works on canals. According to these records, the waterways—of which at least one connected the Nile harbour Schedia with Alexandria—had to be cleaned down to the bedrock at both banks on a regular basis in order to prevent them from silting up and becoming muddy:<sup>39</sup> *foditu(m) est ... at tria soldu(m) usque ad petras*. Such work of grand proportions was—as the example of Trajan’s column also illustrates—a technological achievement par excellence, which visualised the glory and the authority of the emperor and was thus recorded for posterity in the form of inscriptions. By documenting construction projects to improve public safety in

<sup>36</sup> cf. GREWE, *Tunnels* [n. 7], p. 333-336.

<sup>37</sup> *AÉ* 1983, 927 (Küçük Dalyan Köyü, Syria); *AÉ* 1986, 694 = *SEG* 35, 1483 (Antiocheia, Syria); *CIL* III, 12046 (Alexandria, Aegyptus).

<sup>38</sup> *AÉ* 1973, 475 = *ILJug* II, 468 (Karatas bei Sip, Moesia superior): *Imp(erator) Caesar diui Neruae filius* / *Nerua Traianus Aug(ustus) Germ(anicus) / pont(ifex) max(imus) trib(unicia) pot(estate) V p(ater) p(atriciae) co(n)s(ul) IIII / ob periculum cataractarum / deriuato flumine tutam Da/nuui nauigationem fecit*.

<sup>39</sup> *OGIS* 672 = *I Delta*, 332, 3 = 412, 10 = *IGR* I, 1098 = *SB* V, 8902 (Schedia, Aegyptus): ἔτους τρίτου / Αὐτοκράτορος Τίτου / Καίσαρος Οὐεσπασιανοῦ / Σεβαστοῦ ἐπὶ Γαίου / Τεττίου Ἀφρικανοῦ / Κασσιανοῦ Πρίσκου ἡγεμόνος / ὠρύγη Ἀγαθὸς Δαίμων / ποταμὸς ἐπὶ τὰ τρία στερεὰ / καὶ ἐπὶ τὸ ἀρχαῖον ἀπεκατε/στάθη ἕως τῆς πέτρας καὶ / ἐτέθησαν παρ’ ἐκάτερα τῶν τοίχων πλάκες ἐπιγεγραμμέ/ναι δεκατέσσαρες; *OGIS* 673 = *I Delta* 334, 4 = 412, 11 = *IGR* I, 1099 = *SB* V, 8903 (Schedia, Aegyptus): *Anno VI Imp(eratoris) [[Domitiani]] / Caesar(is) Aug(usti) Germanic(i) / sub C(aio) Septimio Vegeto praef(ecto) Aeg(ypti) / foditu(m) est flumen Philagrianu(m) / at tria soldu(m) usque ad petras*. / ἔτους ζ’ Αὐτοκράτ[ορος] / Καίσαρος [[Δομιτ(ια)νοῦ]] / Σεβαστοῦ Γερμανικοῦ / ἐπὶ Γαίου Σεπτιμίου / Οὐεγέτου ἡγεμόνος / ὠρύγη ποταμὸς / Φιλαγριανὸς ἐπὶ τὰ / γ’ στερεὰ ἕως τῆς πέτρας.

the event of natural disasters such as floods<sup>40</sup> or on dangerous terrain<sup>41</sup> the emperors could at the same time emphasise their role as saviours.

#### 4 The Significance of Inscriptions

Considered together, Roman epigraphic documents indeed provide information about technology and innovation in the Roman Empire. Yet, funerary, honorific, or votive inscriptions as well as public records mostly offer only individual bits of information or summary formulations. The reference to expert knowledge and specialised terminology was of no interest to the broad public and was thus only rarely included in inscriptions. According to their function, these monuments rather served as testimonials to the renown of their creators, honorands, or donors. Self-confidence and pride in technological skills or achievements were thereby publicly presented and recorded for posterity. By attesting regulations and measures, public epigraphic documents primarily immortalised the concern of the Roman administration and especially of the emperor for the inhabitants of the empire. The commissioners of such inscriptions on the one hand intended to present their actions to the public, while on the other hand they sought to emphasise their good relations with the emperor as well as underline the ruler's benevolence.

The largest group of inscriptions referring to technological achievements are building inscriptions. They mainly served to document the spending and the commitment of the builders, such as members of the municipal elite or the emperor himself, who presented themselves as generous euergetists. Building inscriptions are thus most likely to mention interesting technological or organisational details as well as innovative approaches. By doing so, the commissioner or financier visualised and perpetuated his honour and fame in a prestigious way. Among these building inscriptions, evidence for road construction under the direction of the emperors is most prominent. This fact may be due not only to the government's effort concerning the traffic system, but also to the omnipresence of milestones. The rhetoric of these texts presents the

<sup>40</sup> *CIL XIV, 85 = ILS 207* (Ostia, Italia): *Ti(berius) Claudius Drusi filius) Caesar / Aug(ustus) Germanicus pontif(ex) max(imus) / trib(unicia) potest(ate) VI co(n)sul design(atus) IIII imp(erator) XII p(ater) p(atriciae) / fossis ductis a Tiberi operis portu[s] / caussa(!) emissisque in mare urbem / inundationis periculo liberavit*; cf. P. ARNAUD, *Maritime Infrastructure. Between Public and Private Initiative* in KOLB, *Infrastruktur* [n. 9], p. 170-172.

<sup>41</sup> *CIL IX, 5947 = ILS 5856* (Paterno, Italia): *Imp(erator) Caes(ar) diui / Neruae filius) Ner(ua) Traianus / Aug(ustus) German(icus) / Dacicus pontif(ex) / maximus trib(unicia) / p[ote]state XV imp(erator) / VI co(n)s(ul) V p(ater) [p(atriciae) s]ub/structionem con[t]ra l]abem montis / fecit*; further on the topic CH. P. JONES, *Earthquakes and Emperors* in KOLB, *Infrastruktur* [n. 9], p. 52-65.

technological achievements as a conquest of nature by the emperor and hence perpetuates his extraordinary authority and quality.

### 5 Economic Goals?

To what extent can these sources provide information about economic goals and consequences of technological achievements and innovations? Although the inscriptions we discussed often correlate technological achievements and building projects, they only rarely make reference to economic aspects. Only Hadrian's letter to the community of Koroneia and the self-praise of the woodworkers from Lycia reveal an obvious economic background, besides mentioning technological methods. Only relatively few other inscriptions, which relate to various significant or prominent technological measures in the proper sense, may be associated with economic policy matters. Among these, surely Hadrian's regulation of the river Kaystros, for which he was thanked in AD129 by the city council and the people of Ephesos, and the edict of the proconsul Lucius Antonius Albus that laid down measures to keep the harbour of the same city clear, are to be mentioned.<sup>42</sup>

When looking at literary sources of the Roman imperial period in search of statements on economic goals and consequences of technological innovations, we find only few and isolated cases. Suetonius reports the anecdote that Vespasian rejected a cost-effective invention for the transport of columns, which is interpreted as an economic or socio-political venture.<sup>43</sup> Cassius Dio's information about Tiberius, who had a glassmaker killed because he had devised unbreakable glass, can be interpreted along the same lines, although Dio primarily concentrates on the motive of the emperor's jealousy.<sup>44</sup> Only the governor Pliny explicitly shows a rational interest in fostering the economy of his province by improving its transportation infrastructure. Thus he suggested to the emperor building a new canal from Nicomedia to the Lake of Sapanka.<sup>45</sup>

<sup>42</sup> *IK XI*, 23 and *IK XII*, 274; cf. *IK XVII*, 3071 (all Ephesos, Asia); for evidence of further, comparable measures see E. WINTER, *Staatliche Baupolitik und Baufürsorge in den römischen Provinzen des kaiserzeitlichen Kleinasien*, Bonn, 1996, p. 185-187; on this dossier see now Ch. KOKKINIA, *Rome, Ephesos, and the Ephesian Harbor: a Case Study in Official Rhetoric* in KOLB, *Infrastruktur* [n. 9], p. 180-196.

<sup>43</sup> SUETONIUS, *Vesp.* 18, 2; cf. otherwise the emperors' building initiatives as measures of employment-creation, e.g. the example of Herodes II in Josephus, *Bell. Iud.* I, 12, 11; on this see WINTER, *Staatliche Baupolitik* [n. 42], p. 129-131; M. HORSTER, *Bauinschriften römischer Kaiser; Untersuchungen zu Inschriftenpraxis und Bautätigkeit in Städten des westlichen Imperium Romanum in der Zeit des Prinzipats*, Stuttgart, 2001, p. 241-246.

<sup>44</sup> DIO LVII, 21, 6; PETRONIUS, *Sat.* 50-51.

<sup>45</sup> PLINY, *Ep.* X, 41 and 61; cf. H. SCHNEIDER, *Infrastruktur und politische Legitimation*

Altogether, the few inscriptions and literary sources that reveal a specific interest in technology with respect to fostering economic procedures without doubt attest the purposeful utilisation and planning of technological methods and innovations in order to boost economic potential. The fact that these matters are only inadequately handed down by literary and epigraphic sources might stem from their predominantly aristocratic viewpoints. Pursuit of profit and economic performance did not belong to the aristocratic ideals and values.<sup>46</sup>

*im frühen Principat* in KOLB, *Infrastruktur* [n. 9], p. 36.

<sup>46</sup> For the discussion about economic mentality see K. RUFFING, *Die Selbstdarstellung von Händlern und Handwerkern in den griechischen Inschriften* in *MBAH* 33, 2004, p. 85-101; G. VIVENZA, *Roman Economic Thought* in W. SCHEIDEL (ed.), *The Cambridge Companion to the Roman Economy*, Cambridge, 2012, p. 25-44.