

The Archaeology of Canadian Potteries: An Evaluation of Production Technology*

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Résumé/Abstract

Des recherches archéologiques sur la poterie canadienne ont été entreprises sur au moins vingt sites. Ces fouilles ont permis d'accumuler des connaissances d'ordre historique et technique sur des poteries et sur des régions particulières. L'un des objectifs de ces recherches était de se renseigner sur les techniques de production de la céramique. À l'heure actuelle, les connaissances acquises par les recherches archéologiques au sujet des anciennes techniques ne sont toujours pas structurées; c'est pourquoi nous n'avons pu établir que des étapes de production isolées, insuffisantes pour permettre de reconstituer le véritable processus de fabrication. Un système hypothétique de production a pu être élaboré à l'aide d'une description générale, faite par David Newlands, d'une chaîne de fabrication typique du XIX^e siècle en Ontario. Pour l'instant, ce modèle heuristique est appliqué à l'ensemble de l'industrie de la céramique. Les chercheurs auraient maintenant avantage à préciser le modèle de base et à émettre des hypothèses sur les modes d'organisation caractéristiques à chaque poterie et aux autres régions. L'examen des recherches menées sur les fours à céramique en Angleterre et aux États-Unis suggère diverses méthodes et orientations qui pourraient être adaptées en vue d'études analogues sur les sites canadiens:

- 1) *Études géographiques et temporelles pour analyser les techniques régionales et les changements de fabrication.*
- 2) *Études des artefacts afin d'examiner la construction des fours.*
- 3) *Études chimiques et physiques des matériaux, des vernis, décors et articles afin de déterminer les techniques de fabrication.*
- 4) *Études des vices de fabrication, des accidents et des réparations à l'aide des artefacts.*
- 5) *Recherches historiques et recherches sur les artefacts afin de connaître les machines et les instruments utilisés.*
- 6) *Fabrication de répliques selon les techniques présumées de l'époque afin de corroborer les hypothèses.*

Archaeological investigations of Canadian potteries have been initiated at no fewer than twenty sites. From these investigations a body of historical and technical knowledge has been developed for specific potteries and regions. One objective of this research has been the documentation of production techniques. At present, knowledge of techniques derived from archaeological research is unstructured, resulting in the identification of isolated production steps, rather than the inference of relatively complete production sequences. Using a generalized account of a typical nineteenth-century Ontario procurement and manufacturing sequence for the production of common wares, prepared by David Newlands, a hypothetical ceramic production structure has been developed. On this heuristic model are based generalizations for an entire industry, and future research should attempt to refine the basic model as well as postulate characteristic structures for individual potteries and other regions. Examinations of research conducted at ceramic kiln sites in England and the United States suggest various methods and problem orientations which could be adapted for such investigations of Canadian sites:

- 1) *Geographic and temporal studies to address regional technology and adaptive change.*
- 2) *Material studies into kiln construction.*
- 3) *Chemical and physical studies of fabrics, glazes, decorations, and wares to deduce manufacturing techniques.*
- 4) *Material studies on manufacturing errors, accidents, and repairs.*
- 5) *Historical and material studies into tool and machinery usage.*
- 6) *Replicative experimentation to evaluate previous manufacturing inferences of pottery manufacturing.*

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Introduction

Knowledge of Canadian pottery technology has been acquired primarily through studies of historic documents, stylistic examinations of Canadian-made wares, and excavations of Canadian pottery sites. Surviving diaries, newspaper accounts, directory advertisements, patents, sketches, and early photographs provide essential fragments of the historical record (Collard 1967; Langlois 1978; Newlands 1979a). Pottery collections preserve evidence of individual potter's skills and artistic abilities (Webster 1969; Newlands 1977a). And within the past two decades, technological evidence has also been acquired through archaeological excavations of abandoned pottery sites.

Unfortunately, few excavations of Canadian pottery sites have been discussed in detail published articles, and few of these articles have substantively developed inferences of technological behaviour or have attempted to reconstruct past technical skills. Interest in the archaeology of Canadian pottery technology continually increases, however, and future research should build upon previous endeavours. For this reason I have chosen to discuss the following questions:

1. What archaeological research has been accomplished and subsequently made available for scholarly use?
2. What is known of Canadian pottery technology?
3. Compared with English and American archaeological research, what new methods might Canadian researchers employ?

Pottery Site Investigations

Since the mid-1960s, archaeological investigations have been initiated at no fewer than twenty Canadian potteries (table 1 and fig. 1). Sites have been excavated to salvage remains before they were destroyed by industrial development, to sample ware styles both from sites with known potters and from sites with known dates of production, and to increase knowledge of previously unattributed sites and wares. Information for the majority of these investigations has been reported within numerous government agency and museum manuscript reports, but gaining access to these reports can often be difficult. For this reason, table 1 probably does not include every site investigated archaeologically. Undoubtedly, a few have been overlooked.

The only sites noted in table 1 which have never been reported are the Selkirk Pottery, excavated in 1968 by Jason Henderson, under the direction of James Chism

(Parks Canada), and the Enfield Pottery, surface collected in 1973 by Donald Webster (Royal Ontario Museum). A portion of the Selkirk Pottery waster dump was sampled, and the remains that were recovered are at present housed at the Archaeology Laboratory of Parks Canada in Ottawa awaiting analysis.

Remains reported from Canadian pottery sites listed in table 1 have consisted of:

1. *In situ* kiln foundations from the Prince Edward Island Pottery, B. Lent Pottery, David W. Burns Pottery, Huron Pottery, Marlatt/Gilbert Pottery, Conestogo Pottery, and the John Kulp Pottery.
2. *In situ* pottery shop foundations from the Conestogo Pottery, B. Lent Pottery (a possible foundation), and Huron Pottery.
3. Pottery debris from waster dumps at most sites.
4. Potters' tools and moulds from the Huron Pottery and David W. Burns Pottery.
5. Marked wares from the Huron Pottery, Brantford Pottery, B. Lent Pottery, and Prince Edward Island Pottery.
6. Kiln furniture from the B. Lent Pottery, Brantford Pottery, Conestogo Pottery, Prince Edward Island Pottery, Huron Pottery, and David W. Burns Pottery.

Previous Research Objectives

Donald Webster (1971b, 227-45; 1974) and David Newlands (1977b, 1979a) have noted that *archaeological research* of Canadian pottery sites can provide three basic types of information:

1. Documentation of pottery locations, pottery structures, dates of operation, and potter affiliations. This documentation is derived by archaeological methods, primarily to supplement and evaluate historical documentation.
2. Documentation of pottery wares and styles.
3. Interpretations of pottery production techniques.

Of these, the first two are regarded as primary or fundamental archaeological objectives. Remains of *in situ* struc-

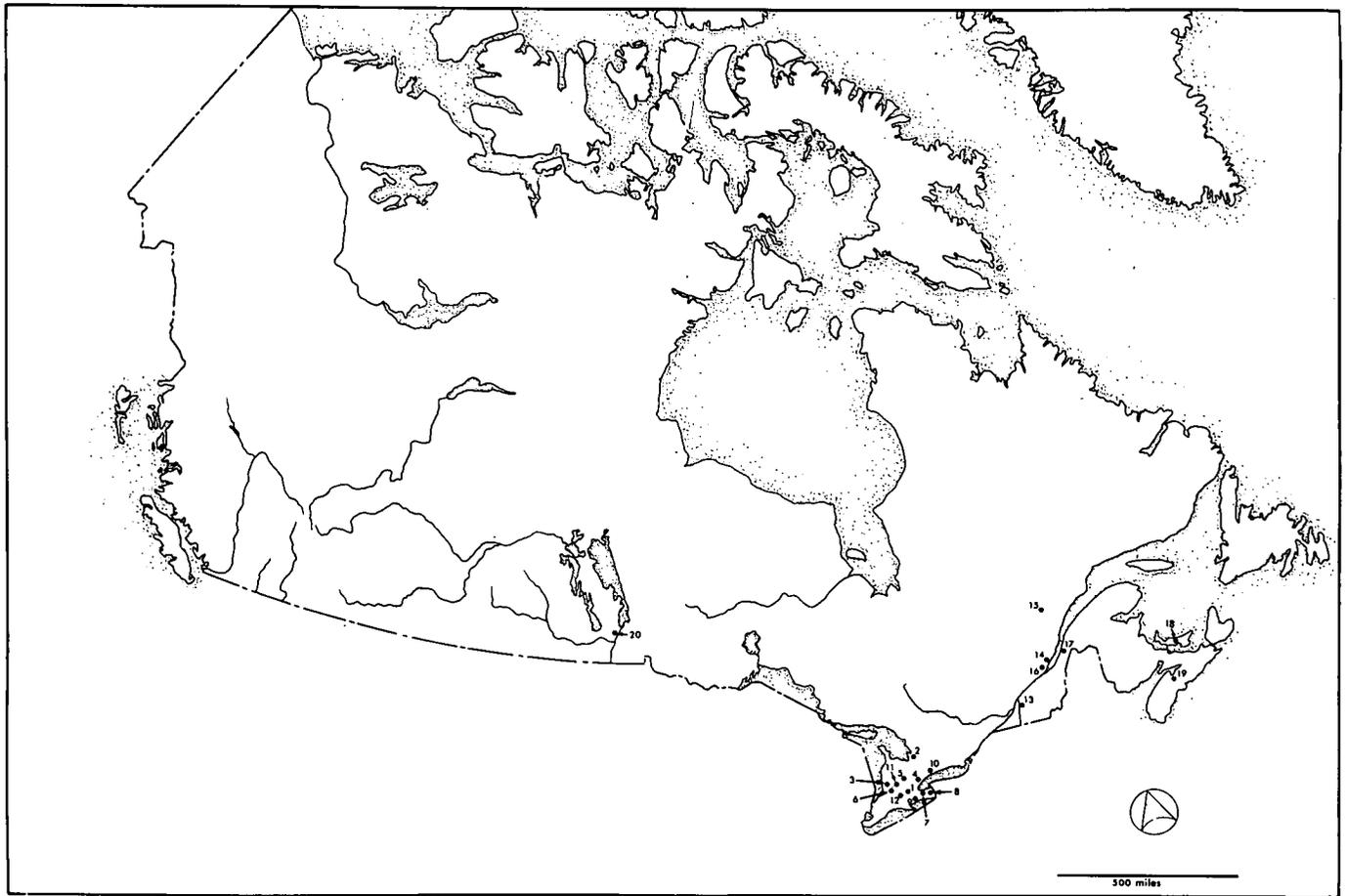


Fig. 1. Geographic distribution of Canadian pottery sites known to have been investigated archaeologically (keyed to table 1).

tures, such as kiln foundations, pottery shop remains, and waster dumps, and *ex situ* artifacts, such as wares, kiln furniture, and tools, are identified, described, illustrated, and discussed for their historical, geographic, and technical significance. The third objective is regarded as an interpretive conclusion inferred from the study of archaeological remains, and perhaps looked at with primary historical evidence. Compared with pottery site research in England and the United States these three objectives demonstrate that Canadian research is emerging from a formative stage of development.

The first two objectives are requisite for any pottery site research, with the quality of archaeological documentation dependent upon the skills of individual researchers. Such documentation consists of drafted plans for surviving remains, lists of artifacts, collections of remains, photographic or graphic illustrations of surviving and reconstructed remains, manuscript reports for archival storage and published accounts in scholarly journals.

Use of such documentary evidence depends upon the particular interests of researchers who participated in ini-

tial excavations, or upon the availability and comprehensibility of this evidence to others within the research community. Unfortunately, effective communication of documented information has been difficult to accomplish except when publication of a major work or article has been undertaken. However, because of costs and the limited number of scholarly journals, few printed pages have been devoted to documentary accounts. Rather, discussions of historical relevance have predominated. Thus far, published documentation has been provided for kiln structures, samples of stylistic products, and examples of kiln furniture, with emphasis placed upon technological interpretations. These interpretations have been preliminary rather than exhaustive, and they have yet to address ceramic technology from a broad historical perspective.

Within the discipline of history, particularistic technological research is typically integrated within broader topics such as economic and industrial history. If attention is directed towards specific techniques of production, then these techniques are viewed in relation to energy sources, labour, tool and machine usage, economic values, commercial suppliers and markets, previous cultural tra-

TABLE I
Canadian pottery sites known by the author to have been investigated archaeologically*

Pottery Site	Dates	References
Ontario		
1. Brantford Pottery	1849-1905	Webster 1968; Newlands 1979a, 134-47
2. Brittain Pottery	ca. 1860s-97	Newlands 1979a, 89 and pers. comm.
3. David W. Burns Pottery	1860-ca. 1900	Newlands 1974b, 1976b-c, 1977a, 1979a, 120-23, 1979b, 1979c, 2,4
4. Bernard Collins Pottery	ca. 1849-65	Newlands 1979a, 81
5. Conestogo Pottery	1843-1906	Webster 1971a; Newlands 1979a, 106-8, 1979c, 4
6. Huron Pottery	1852-1910	Newlands 1974a, 1975, 1976a-c, 1977a, 1979a, 112-19, 1979c, 4
7. John Kulp Pottery	1829-ca. 1870s	Tracey 1966, 1967; Newlands 1979a, 165-66, 1979c, 1,4
8. B. Lent Pottery	ca. 1820s	Rupp 1978-80; Newlands 1979a, 163, 1979c, 2
9. Abraham Marlatt/ Ebenezer Gilbert Pottery	1864-98 1872-1900	Sutermeister 1969; Webster 1971b, 238-39; Newlands 1979a, 168-70, 1979c, 4
10. John Burns/ Markham Pottery	1855-84	Sutermeister 1969; Webster 1971b, 8; Newlands 1979a, 78-79
11. New Hamburg Pottery	ca. 1851-1916	Newlands 1977c, 1978, 1979a, 109-10
12. John Yeigh Pottery	ca. 1803-late 1820s	Newlands 1979a, 124-25
Quebec		
13. Saint-Denis Potteries	1785-1888	Gaumond and Martin 1978
14. Cap-Rouge Pottery	ca. 1860-1900	Gaumond 1971, 1972; Webster 1971b
15. Charles Bebeau Pottery	1828-89	Langlois 1978, 29
16. Pierre Côté Pottery	1803-16	Langlois 1978, 42; Ms. on file at the Ministère des Affaires culturelles (centre de documentation); Jean-Pierre Cloutier, pers. comm.
17. Charles Joubert Pottery	1818-41	Langlois 1978, 94; Ms. on file at the Ministère des Affaires culturelles (centre de documentation); Jean-Pierre Cloutier, pers. comm.
Prince Edward Island		
18. P.E.I. Pottery	ca. 1880-95	Webster 1971b, 32-33, 89, 228-29; also see the article by Webster in this volume
Nova Scotia		
19. Enfield Pottery	-	Donald Webster, pers. comm.
Manitoba		
20. Selkirk Pottery	1879-1906	Jason Henderson, pers. comm.

* Sites are keyed to figure 1.

ditions, etc. Although a few of these aspects have been addressed by Canadian archaeologists, historical integration of information such as this has not been pursued actively within scholarly publications.

Within the discipline of North American archaeology, research emphasis is often placed upon the identification of technological change, on attempting to identify adaptive, developmental, and evolutionary processes which affect changes in ceramic technology. In Canada, emphasis upon change has been lacking since few sites have been excavated, and thus comparisons must await additional research. But what of our current level of knowledge? What is our understanding of past Canadian technology, specifically regarding pottery production techniques?

Pottery Production Techniques

Research of historic ceramic production techniques has relied upon two resources for evidence: (1) historical resources, including documentary descriptions of manufacturing activities, financial transactions, materials, idealized techniques, tools, and machines; and (2) archaeological resources, including remains of raw materials, tools, machines, rejected wastage, and finished products. Technologists could also utilize contemporary folklife studies and replicative experimentation to evaluate inferences of past techniques and products, but to date these methods have largely been ignored or regarded as unnecessary.

Documentary remains exist in various archives, libraries, government record offices, and individual family records. Evaluation of these sources for technological information has been initiated by such researchers as Elizabeth Collard (1967, 249-321) for nineteenth-century Canadian potteries and David Newlands (1979a) for nineteenth-century Ontario potteries. Historians have also utilized historical resources to document technological aspects of specific Canadian potteries or pottery production regions. For example, the Medalta Pottery in Medicine Hat, Alberta (Antonelli and Forbes 1978), the potteries of Saint-Denis, Richelieu River, Quebec (Gaumont and Martin 1978), and the New Hamburg Pottery in Ontario (Newlands 1978). Others have also attempted to identify all potters or potteries within a given region or temporal period. For example, the historical surveys completed by Helen Lambart (1970a, 1970b) on the Richelieu Valley, Saint-Charles, and Cap-Rouge potters; Jacques Langlois (1978) on mid-seventeenth- to early twentieth-century Quebec potters, and David Newlands (1979a) on nineteenth-century Ontario potteries. In a unique study, Langlois traced French origins for Quebec potters, an extremely creative approach which should allow future researchers to address stylistic origins and adaptive changes. Newlands, in his study, sought to trace

the economic growth and decline for each pottery identified within Ontario. This approach has already laid a temporal foundation for site-specific research but, even more importantly, this regional study has isolated a number of causes of growth and decline. These types of studies demonstrate the wealth of historical documentary evidence available for more exhaustive research.

Material remains of Canadian potters' skills may be as numerous as historical records, if not more so. The majority of these remains consist of products still in use, older wares retained as antiques within private and public collections, and surviving remains acquired through archaeological excavations. Ceramic objects still in use can provide technical evidence, provided pieces are well dated and authenticated. However, detailed technical studies of such pieces are difficult to undertake, and limited attention has been given this research method. One of the major problems is obtaining an adequate sample of wares from a known period and a specific pottery. Partial solutions have been found by creating representative collections of wares within research institutions such as museums, universities, and heritage interpretation agencies. Even though such collections exist in many provincial and federal museums, research has been limited and sporadic, resulting primarily in the creation of exhibits. However, a few publications have appeared, for example, Donald Webster's (1969) book on Canadian slip-decorated pottery, as well as his (1971b) volume on early Canadian pottery. The best information source for material culture research, however, consists of pottery-specific remains recovered by archaeological research, but, as mentioned earlier, previously collected technical evidence lacks substantive documentation in print.

Technical inferences are generally site-specific, yet not one complete technical production sequence has been induced for a single pottery. At the Brantford Pottery, Donald Webster (1968) provided evidence for ware formation by throwing; decoration by slipping, glazing, painting, incising, and press moulding; and kiln stacking. At the Conestogo Pottery, he (1971) broadened his approach to discuss clay procurement, pugging, and cleaning; ware formation by throwing; decoration; kiln construction, stacking, and firing; glaze procurement and application; and waster disposal. At the David W. Burns Pottery, David Newlands (1974b, 1977a, 1979b) discussed construction of a rectangular cross-draft kiln, as well as the sprigging and glazing of wares. For the Huron Pottery, he (1976a, 1976c, 1977a) discussed the construction of a circular down-draft kiln, as well as the sprigging of wares. Finally for Ontario, at the B. Lent Pottery, David Rupp (1978-80) discussed ware shaping; decoration by stamping, incising, and painting; glazing; kiln construction; kiln furniture manufacture and usage; and waster disposal. For Quebec, limited technical information has been reported. The only stages of pottery produc-

tion at Cap-Rouge addressed by Michel Gaumond (1972) was ware shaping and decoration. For the potters of Saint-Denis, Gaumond and Louis Martin (1978) concluded that wares were turned by individual family potters using local clays. These wares were then slipped, bisque-fired, commonly covered with a lead glaze, and fired for a final time without the use of kiln furniture. These interpretations provide unique insights into the specific techniques utilized at individual potteries, but by themselves they only characterize particular production events and do not infer a production sequence.

Pottery Production Structures

Archaeological research of product production, whether it be ceramic or lithic technology, is the study of human behaviour, specifically, the induction of sequences of technical activities for manufacturing products. These sequences, known as *production structures*, attempt to model the organization of technical labour, energy flow, and material inputs and outputs. As models, pottery pro-

duction structures represent technical hypotheses of past behaviour induced from evidence obtained from analyses of remains from historical and archaeological records. As hypotheses, structures serve as predictive statements for the identification of new evidence, as research plans for generating as yet unobserved stages of production, and as conclusive statements to be evaluated by additional historical, archaeological, and ethnographic research, as well as by replicative experimentation. A structural approach for addressing human organization and activity conceptualizes human behaviour as a dynamic sub-system participating within broader cultural-ecological systems of natural and cultural processes. Production structures are heuristic mechanisms for conceptualizing sequentially related production events, and each proposed structure is regarded only as one approximation of a complex reality. Any activity can be structured.

An activity, perceived in hindsight, can be conceived as a finite series of specific stages or events. An observed pottery production activity could consist of a simplistic sequential structure, such as clay procurement, clay mixing, ware formation, bisque firing, ware decoration, and

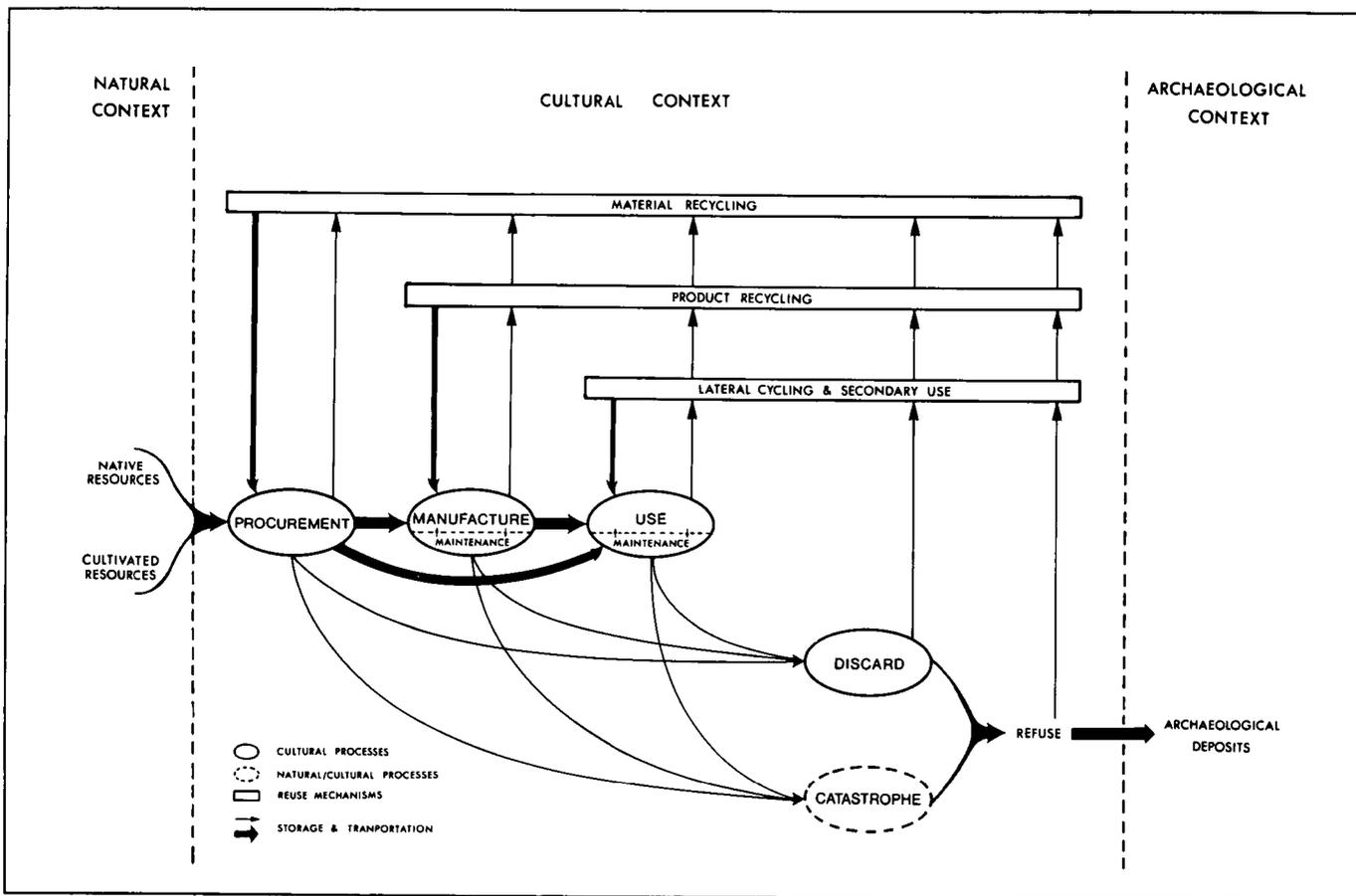


Fig. 2. Material production structure of cultural processes affecting the transformation of material within a complex craft such as pottery production (following Ross 1982).

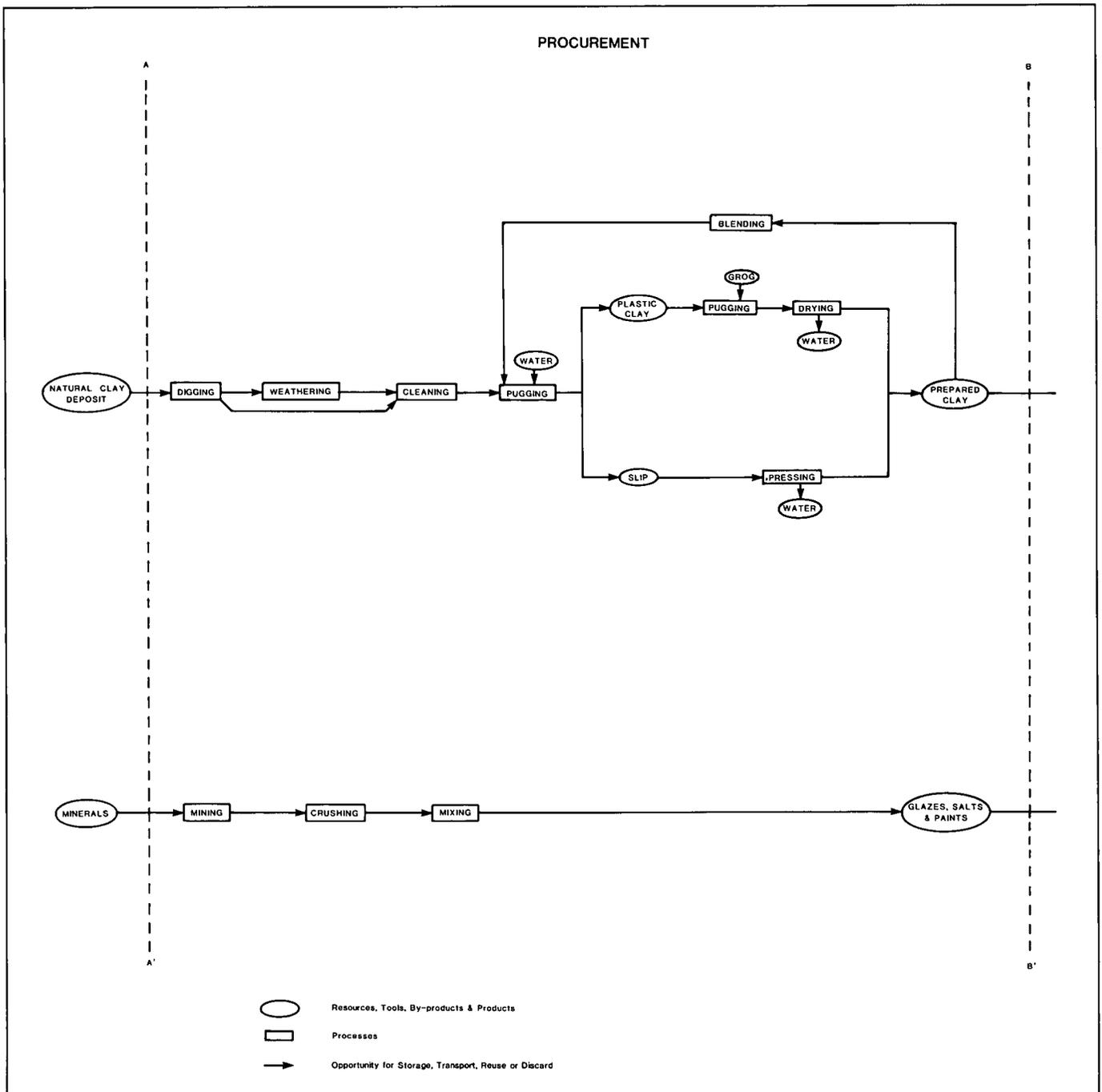


Fig. 3. Hypothesized pottery procurement stages for clays, glazes, and paints for nineteenth-century Ontario potteries (following Newlands 1979a).

glost firing. Or the same activity could consist of an extremely complex structure identifying every human movement, correlating time and locality with each movement, relating the inputs and outputs of all materials, the flow of energy, use of tools and machinery, equating economic values with inputs and outputs, etc. The level of complexity is determined partially by available evidence but, more importantly, by the scope of the research inquiry. For archaeology, research scope is restricted gener-

ally to surviving material remains of actual behaviour. For the historical period, however, evidence can also be obtained for ideal (i.e., normative) or consciously perceived behaviour. Thus, historical archaeologists have a broader and far deeper data base than their prehistoric brethren. This situation, however, is both a blessing and a bane. Vast resources are available, yet actual use of such resources can overwhelm attempts at observation and synthesis. Utilizing a structural approach for modelling past

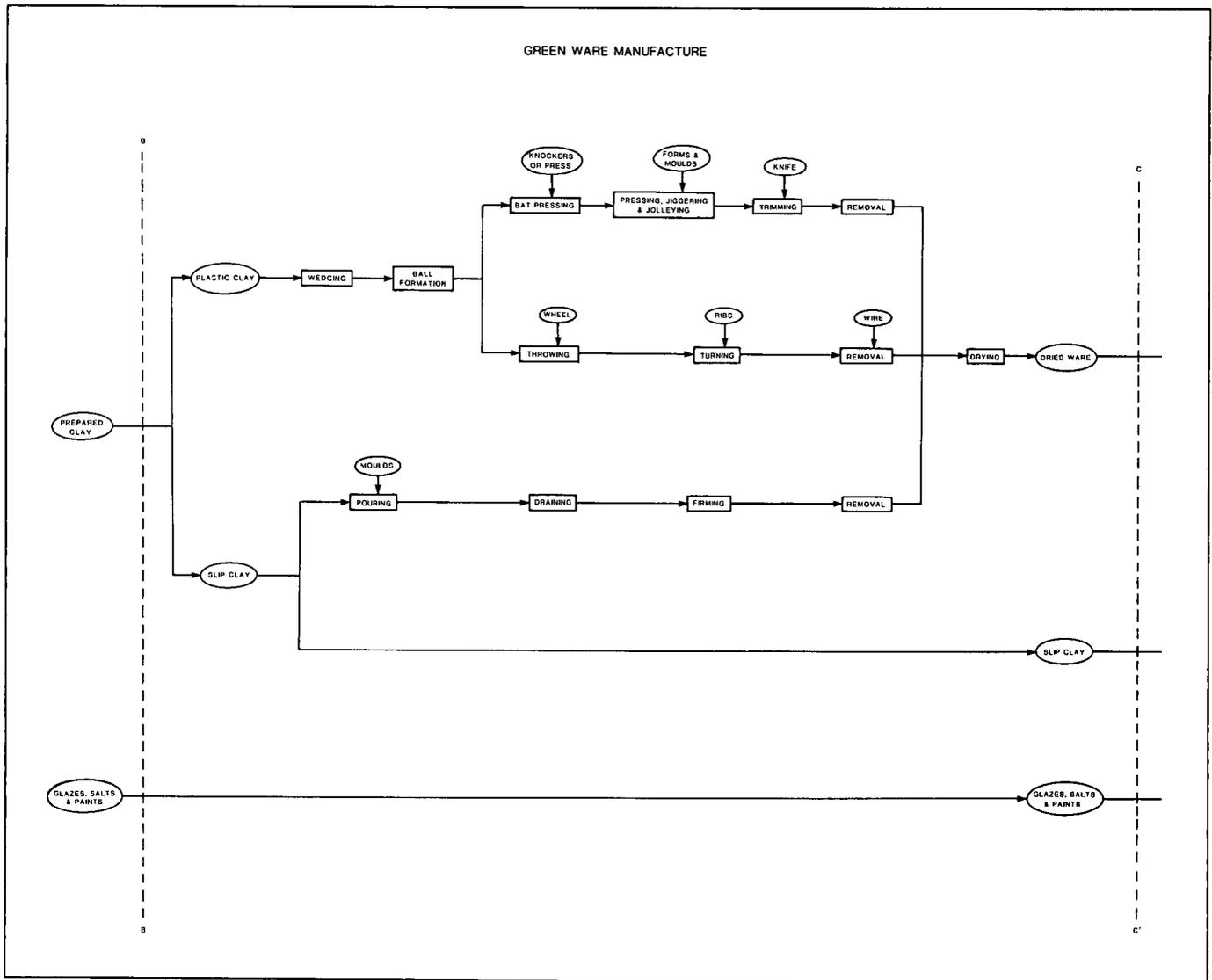


Fig. 4. Hypothesized pottery-manufacturing stages depicting green ware shaping for nineteenth-century Ontario potteries (following Newlands 1979a).

behaviour can simplify conceptions, as well as provide a basis for expanding knowledge in manageable increments. Where to begin however?

Complex crafts and industries, such as ceramic technology, appear to be comprised of relatively few major cultural processes. For complex industrial crafts, a production structure could rely upon major cultural processes such as procurement, manufacture, use, maintenance, discard, catastrophe, and various forms of reuse (Schiffer 1972; Ross 1982). Modelling the potential flow of material through these processes demonstrates interrelationships which subsequently could be of significance to any specific industry (fig. 2).

Application of this general model to historic pottery production in Canada has yet to be undertaken, although David Newlands (1979a, 4-21) has provided an unstruc-

tured approximation of a generalized pottery-manufacturing sequence for Ontario potteries of the nineteenth century. Newlands's reconstruction addresses procurement and preparation of clay; techniques of ware formation, drying, marking, decorating, glazing, and firing; and ware storage, packaging, and shipment. Comparing his stages of production to the general model (fig. 2), it can be argued that he was addressing only the processes of procurement and manufacture. To be complete, the processes of distribution, utilization, maintenance, discard, and reuse should also be considered. If we were only to examine the techniques mentioned by Newlands, however, then a material flow model could be created to perceive significant interrelationships among raw materials, technical stages, and material outputs (figs. 3-6).

Procurement of clays, minerals, grog, etc., can rely either on the mining of local materials or on the importa-

tion of regional or foreign materials. These materials may be stockpiled on a pottery site, and evidence for their existence may survive a multitude of cultural and natural transformation processes, subsequently to be preserved for the archaeologist. Newlands implies that clay procurement at any specific pottery may include activities such as digging, cleaning, pugging, blending, pressing, and drying (fig. 3). Precise sequences depend upon the scale and complexity of individual pottery operations, and modeling specific sequences could be undertaken by analysing pottery-specific historical and/or archaeological remains.

Turning to the hypothetical manufacturing process addressed by Newlands, there appear to be five major stages of activity: (1) green-ware shaping, (2) decoration, (3) bisque firing, (4) glazing, and (5) glost firing (figs. 4-6). Green-ware manufacture begins with prepared clays, either in a plastic or slip state. To remove unwanted air bubbles, plastic clays must first be wedged. Sub-

sequently, a clay ball is formed to the desired size or weight for the intended vessel form. If the ball is thrown on a wheel, it most probably would have been shaped by hand, with or without the use of moulding aids such as ribs or patterns. In addition to throwing, wares could also be shaped through the use of machinery. Such activities as pressing, jiggering, and jolleying have been noted historically, both in conjunction with and without the use of hand-held patterns. The third technique of green-ware shaping was slip casting, involving the pouring of liquid clay into plaster moulds. Finally, all three techniques involved air drying to remove excess water prior to decoration or bisque firing.

After drying, wares could be trimmed to remove unwanted clay and/or turned on a wheel to complete final shaping. Wares could be marked and/or decorated by impressing, inscribing, printing, painting, and applied moulding, or just decorated by slipping, slip trailing, and

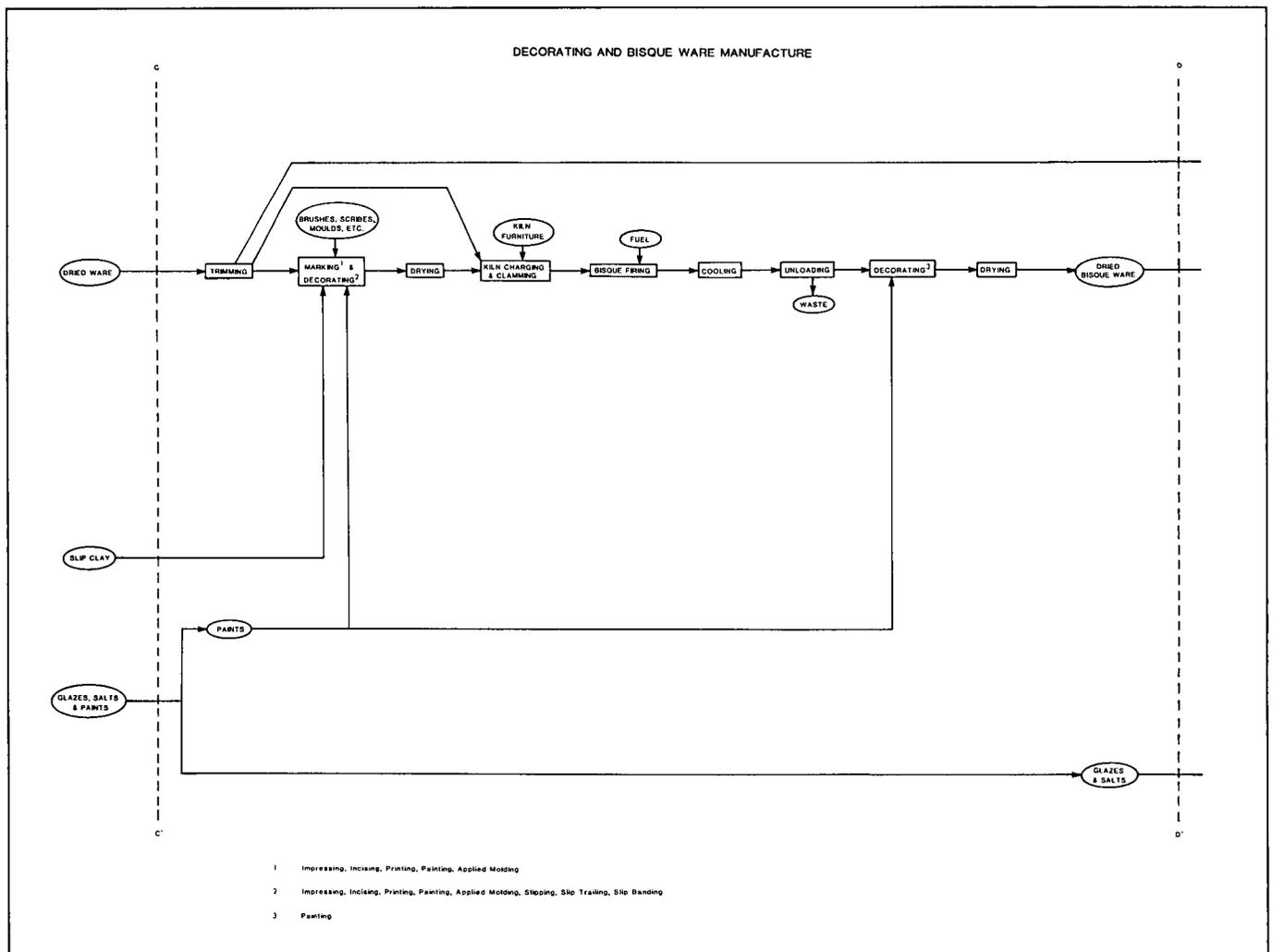


Fig. 5. Hypothesized pottery-manufacturing stages depicting marking, decorating, and bisque firing for nineteenth-century Ontario potteries (following Newlands 1979a).

slip banding. Subsequently dried again, wares were then loaded into a kiln for their first or bisque firing. After cooling, bisque wares could then be further decorated by painting.

Decorated wares were invariably glazed to seal paints against abrasive damage during use. Many wares were undecorated and had only a glazed interior and/or exterior surface, while other decorated wares could be fired unglazed. After applied glazes had dried, wares then received their final or glost firing. For stonewares, chemicals could be introduced into the kiln during this stage to produce a salt glaze. Finally, after cooling, finished wares were unloaded from the kiln and packaged for shipment.

This hypothetical material production structure conceptualizes a generalized sequence which should serve as a heuristic model for future archaeological and historical re-

search. It is not a profound model derived from intensive behavioural research, nor is it a specific model for a single known pottery. Rather, it is a speculative model to stimulate the creation of more elaborate and pottery-specific models; and to be useful for future research, it is noted that this general model should be evaluated: (1) by inducing pottery-specific models, (2) by inducing ware-type models from the analysis of known wares held in various collections, (3) by postulating and inferring variability in techniques and product/by-product outputs, and (4) by observing present-day ceramic production and utilizing replicative experiments.

Future Research Objectives

During the past two decades, archaeological research of pottery sites in England and the United States has demonstrated methods which could be applied to technological

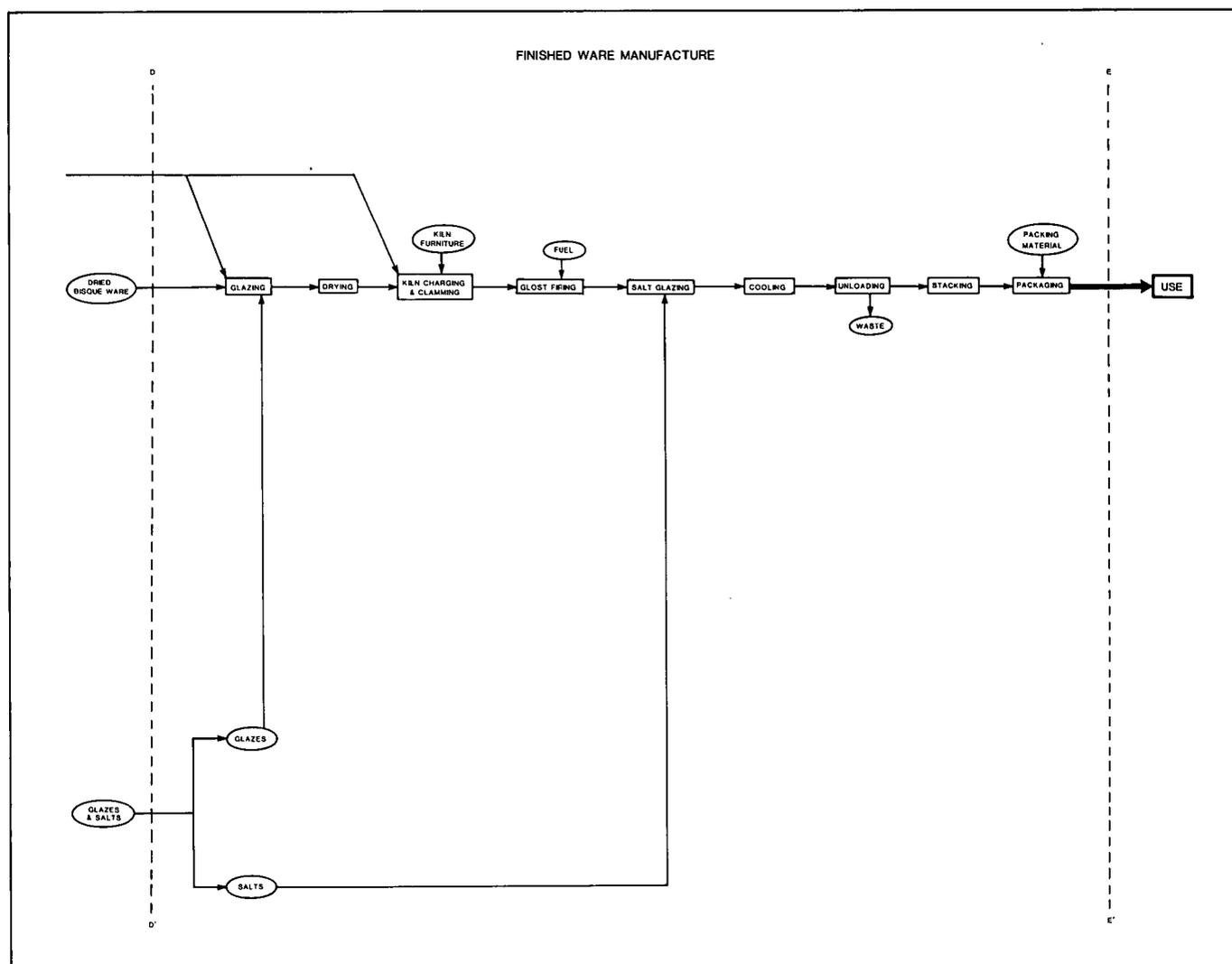


Fig. 6. Hypothesized pottery-manufacturing stages depicting glazing and glost firing for nineteenth-century Ontario potteries (following Newlands 1979a).

research objectives previously expressed for Canadian pottery site investigations:

1. Geographic and temporal studies to address regional technology and adaptive change.
2. Material studies into kiln construction.
3. Chemical and physical studies of fabrics, glazes, decorations, and wares to deduce manufacturing techniques.
4. Material studies on manufacturing errors and repairs.
5. Historical and material studies into tool and machinery usage.
6. Replicative experimentation to evaluate previous manufacturing inferences.

Before these methods are discussed, it is important to recall that emphasis is being placed upon techniques for deriving inferences of past ceramic technology, specifically for the explication of knowledge focusing upon ceramic production. Since archaeological research is primarily based on the analysis of material remains, the investigation of technical behaviour must rely the technical classification of remains. To achieve this objective, surviving material remains are classified on the basis of physical and chemical attributes which identify technical production processes. Classifying such remains according to strictly stylistic or functional attributes limits technical inductions, although such attributes in conjunction with technical attributes expand inferential possibilities. For ceramic technology, artifact types may be denoted by such descriptive terms as "refined white earthenware," "salt-glazed stoneware," "salt-decorated redware," if an explicit relationship has been established with a well-known process of production. Often, however, such terms are incorrectly used as stylistic indicators, conveying vague technical information. An initial research emphasis must be placed upon technical classification, not just for finished products, but also for by-products, tools, fuels, architectural structures, etc. Specific classification systems and typologies need not be standardized throughout the discipline (although this would be desirable in many circumstances). However, terms do require explicit definitions when employed in an analytical and inferential manner.

Geographic and Temporal Studies

As David Newlands demonstrated in Ontario, regional distributions of potteries, together with the acquisition of comparable economic and temporal information, can provide significant evidence for documenting changes in technical processes. In a regional survey of Welsh potteries, Eric Talbot (1969) focused on the dissimilarities of local versus imported ceramics, seeking to examine the development of local potteries to serve local markets.

Talbot's approach does not differ greatly from Canadian research, but his emphasis on the definition of locally produced wares to investigate the relationship of imported ceramics to burgeoning industrial development was unique.

David Freke (1979), in his research on a sixteenth-century pottery kiln in Sussex, also relied on the identification of imported ceramics to provide information regarding pottery-specific usage, rather than for regional comparative purposes. Identification of imported wares at a pottery site can help distinguish techniques or styles which local potters were attempting to reproduce. If imported wares served as an impetus for development of new products, experimental results should survive in waster dumps. Neither Talbot nor Freke utilized imported wares for this type of research, but their emphasis upon the identification of such wares at pottery sites illustrates an awareness of probable significance. Knowledge of local and regional products thus serves two useful locational objectives: (1) it helps to define technical skills available to local potters, and (2) it can be used to trace diffusion of ideas from one region to another.

To fulfil these locational objectives, knowledge of regional ware production must be accurately placed in time. Exact dates of production must be correlated with specific pottery techniques. Sylvia Pryor and Kevin Blockley (1978) undertook the analysis of pottery from a seventeenth-century pottery at Woolwich. Based upon the technical dissimilarities of the wares produced, four phases of production were inferred. The first was attributed to Dutch potters while the latter three to German potters. Attempting to define temporal periods of production assists in the identification of synchronic activities, that is, events with a limited date range. Artifacts within a pottery site generally represent a relatively long period of production since they reflect the period the pottery was operated. Subdividing this period into smaller units allows comparisons to be made between initial and terminal periods, thus providing access to knowledge of adaptive, developmental, or evolutionary change. This subsequently will refine inferences of regional development.

One additional approach yet to be incorporated with regional pottery studies is a method referred to as *catchment area analysis* or *site catchment analysis*. Defined by archaeologists addressing the historical geography of resources utilized by a specific human settlement (Vita-Finzi 1969; Vita-Finzi et al. 1970), this method has also been applied by others to address problems of seasonal movements of human populations over a landscape (Jarman 1972) and changes of land utilization through time (Ellison and Harriss 1972). For ceramic technology studies the method can be used to examine both geographic regions and economic networks utilized by specific potteries both to acquire materials and to distri-

bute finished products. For example, for Lower Canada: Where were clays procured and what distances were involved in their transportation to potteries? Were minerals for glazes and pigments imported and, if so, from where? What was the fuel procurement network for wood and/or coal? Catchment area analysis seeks to define geographic areas exploited for material inputs. Knowing the area utilized and the mechanisms employed for procurement, one can even correlate economic costs and labour expenditures to address production expenses and evaluate industrial growth and decline from an economic perspective. Entire regions could also be examined in a similar manner.

Kiln Construction, Usage, and Maintenance

Canadian archaeologists recognize the significance of kiln excavations for determining pottery-firing techniques. Kiln remains demonstrate the types of kilns utilized, and remains of kiln furniture illustrate how wares were stacked. Often, however, kiln marks on wares both recovered at the pottery and attributed to the potter who used the kiln are either ignored or undocumented. Ceramic stacking techniques should be carefully examined, and an entire section of a pottery-specific report devoted to discussions of both the evidence and the possible changes in techniques through time. Hugh Tait and John Cherry (1980) concentrated on this technical aspect for the eighteenth-century Longton Hall Porcelain Factory in Staffordshire, noting that many furniture pieces served multiple functions, a few of which were possibly unique to the pottery in question. Variability in styles and sizes were also noted, but technical inferences were not offered to explain this diversity. Another aspect not addressed was temporal change, perhaps because of the complexity of the pottery and its operation.

Along with stacking techniques, inferences regarding kiln usage can result from examination of kiln products, by-products, and structural remains. In his ongoing research on the eighteenth-century Yorktown Pottery in Virginia, Norman Barka (1973, 1979; Barka and Sheridan 1977) inferred both salt-glazing techniques and firing procedures for two kilns. Analyses included structural examinations, specifically the damage produced by introduced salts, correlating inferences with technical studies of waster remains and finished wares. The kiln structure itself provided extensive information for kiln usage, but normally archaeological research will only be able to address foundation remains which were well used and often heavily damaged.

Various researchers have traced the history of kiln construction attempting to correlate historical descriptions with surviving remains (Barka 1973, 1979; Kelso and Chappell 1975; Tait and Cherry 1978). The most concise functional and stylistic descriptions of ceramic kilns were prepared by Georgeanna Greer (1977, 1979). Her major

emphasis has been on the history and development of rectangular groundhog kilns, tracing their history and comparing surviving examples with historical descriptions. Technical studies of other kiln styles should follow along Greer's substantial contribution, concentrating upon the identification of functional and regional variability. David Newlands (1979c) noted that excavated Canadian kilns were commonly circular, up-draft types, with a few down-draft, cross-draft, and rectangular up-draft varieties. Canadian remains could be compared with similar earthenware and stoneware kilns excavated in England and the United States, but unfortunately most Canadian examples post-date the eighteenth century, and may therefore represent later technological periods than the majority excavated outside the country.

One aspect of kiln construction rarely mentioned is the use of structural materials. Hugh Tait and John Cherry (1978) devoted one section of their report on the four kilns of the Longton Hall Porcelain Factory to descriptions of bricks, plugs, tiles, and fire bars used in construction. Some bricks were curved, glazed on one surface, and individually numbered; others were curved with projections for interlocking; still others were triangular in cross-section; while paving bricks were flat and rectangular. All presumably had specific functions and were intended for specific areas within the kiln. Ceramic plugs, tiles, and fire bars were also associated with the Longton Hall kilns, functioning as dampers and closures for regulating air flow. Kilns from other sites demonstrate that bricks and tiles were not the only building materials employed in construction. At the Conestogo Pottery in Ontario, Donald Webster (1971a) reported use of stone for the kiln floor. Still other sites document the use of plaster and mortar for chinking and sand for floors.

Finally, the knowledge derived from kiln excavations should be used to reconstruct visual appearances and functional operations of past potteries. Kiln reconstructions can be plan views of foundations, cross-sectional views of the entire structure, or three-dimensional views representing a restored appearance (Mayes 1969; Greer 1977; Malone et al. 1979). Similarly, construction, stacking, firing, unloading, cleaning, and repairing techniques can be inferred and depicted visually (Mayes 1969). Technical and functional inferences provide data for future scholarly evaluations, while graphic reconstructions serve more immediate needs for visual communication, both for scholarly research and public interpretation.

Ware Manufacturing Techniques

One of the major purposes for excavating a pottery is to identify the wares produced there. Remains of finished wares invariably consist of damaged waster, and stylistic variability is often the rule. Ignoring, for the moment, damage and error, the most significant attributes for ware

classification and variability include (1) rim configuration, (2) vessel form and size, (3) fabric composition, (4) decoration, and (5) slipping and glazing.

Vessel forms should be based upon functional distinctions, preferably within the cultural context of the period being investigated. For the seventeenth-century Chesapeake Bay area, Mary Beaudry and others (1983) proposed a classification system based upon historic terminology and descriptions. Such a system serves to integrate researchers' formal observations with period perceptions, and if variability is built into the system, rather than excluded, then functional definitions can serve as a basis for further subdivisions based upon technical or stylistic attributes. Jeremy Haslam (1975) utilized a functional system to categorize wares from a seventeenth-century Hampshire pottery. Ware types were first defined, then variations attributable to technical activities were discussed. Brian Bloice (1972) excavated two late seventeenth- to early eighteenth-century tin-glazed earthenware kilns in Lambeth, and used ware variations, together with historical accounts and kiln observations, to help infer manufacturing techniques employed by the potters. Often, variations and production errors provide the most significant information for inducing techniques of manufacture, but following an Anglo heritage for order and symmetry, regularity and standardization may be sought, ignoring evidence of abnormality, experimentation, and inventiveness. For technical research, variability is the key for the discovery of normative behaviour. David Freke and Jill Craddock (Freke 1979, 87-114), in their analysis of the wares from a sixteenth-century kiln in Sussex, formally divided vessel forms into subtypes, specifically identifying all variations observed. This approach allowed the frequency of variations to be calculated, thus permitting quantifiable inferences of stylistic preferences to be made. By extension, the same approach could be taken with formation processes used to create idealized forms for entire regions.

Vessel form and function are complex characteristics of ceramic wares, partially reliant upon the malleable nature of the fabric, vessel formation processes, and vessel size. The size of a vessel can be a determinant of function (When does a cup become a mug, or a plate a platter?), and it can also be regarded as a determinant of the style allowable for a given functional form. Similarly, the obverse can also be argued. Formation processes used to create size, style, and form can be regarded as dependent behaviour, thus retrievable through analyses of observable attributes. Most researchers are familiar with attributes of throwing versus moulding, but what of jiggering, jolleying, pressing, trimming, or separation from the wheel or mould. Attributes of these formation stages could be observed readily; unfortunately, they are rarely reported or used to induce technical behaviour. Similarly, fabric composition is also a determinant of form, and performance

characteristics of clays provide knowledge as to the limitations affecting the appearance of the finished product.

Usually, archaeologists characterize fabric composition by a shortened term or referent (for example, red ware, refined white earthenware). Unfortunately, such characterizations obscure performance and quality characteristics of the clays. Fabric analyses, such as the one performed by Anthony Streeten on the sixteenth-century wares from a kiln in Sussex (Freke 1979, 114-16), usually stress the textural and chemical constituents of the clay, often in an attempt to "fingerprint" the wares of a known pottery. Streeten, however, noted that relative quality could be determined from such an analysis, and that with this information local market areas for "seconds" might be defined. Fabric analyses can also provide information for addressing questions regarding the skills of the potter. Were clays well prepared, too wet, too dry, easily deformed, too coarse, improperly tempered, etc.?

Glaze composition also provides similar potential for technical research, although glaze descriptions tend to be characterized more frequently by common terminology such as lead glaze. Jeremy Haslam (1975) classified lead glazes on seventeenth-century wares from Hampshire potteries into three types: yellow, green, and mottled brown, relating colour to the inclusion or exclusion of copper, manganese, and iron. A similar analysis was undertaken by Donald Webster (1971a, 26-28) for the glazes on wares from the Conestogo Pottery in Ontario. Relative amounts of elements present in glazes were reported, with major colouration attributed to the presence or absence of iron. To be of substantive technical value, however, glaze compositions require extensive analyses addressing the percentage of constituent elements, the methods of application, and correlations with fabric compositions, firing temperatures, and kiln atmospheres.

Georgeanna Greer (1971) noted that American stoneware glazes (high temperature glazes) were either the product of pure salt vapour, slip clay, or alkaline glazing. She provided methods for distinguishing characteristics of each type of glaze, concentrating upon the recognition of alkaline glazes. Again, as with recognition of attributes for vessel form, glaze classifications must also consider variability as well as minor adaptive and developmental changes through time. Kiln sites, with associated waste dumps, provide an excellent opportunity to address techniques of glazing, especially if high quality finished products from the same pottery can also be compared and evaluated to wastage and experimental errors.

Along with specialized analyses of ware composition, preferred and tolerated firing temperatures associated with bisque and glaze firings should be established. For a seventeenth-century kiln site in Northamptonshire, M.S. Tite determined an equivalent firing temperature range of

900°-930°C for coarse red ware dishes fired in a small circular up-draft kiln (Mayes 1969, 80-82). His method, based upon calculations of thermal expansion during controlled periods of refiring, provided an estimated average temperature for glost firing. Using bisque and glazed wastage from kiln sites, it should also be possible to determine both bisque and glost firing temperatures. As noted earlier, ware variations and errors provide evidence for a variety of technical inferences. These errors can be useful for firing temperature determinations.

Manufacturing Errors and Repairs

The most abundant type of artifacts recovered from a pottery site are damaged remains, including (1) production errors, and (2) worn or used debris. Waster dumps provide a wealth of quantifiable information regarding mistakes made during stacking, firing, and kiln unloading. However, pottery wastage can often be recycled, thus skewing debris frequencies towards minimal damage estimates. Slightly damaged wares or "seconds" can be sold at reduced prices, and severely damaged bisque waste can be reground for temper or reconstituted clays. In his study of the seventeenth-century kilns in Northamptonshire, Philip Mayes (1969, 68-69) noted errors tended to consist of mechanical failures and firing mistakes. David Freke (1979, 110-11) identified nine varieties of errors for the sixteenth-century kiln in Sussex. Quantifying these errors, Freke noted that two-thirds resulted from over- and under-firing; one-third resulted from blistering, cracking, and glaze faulting; while approximately 1 per cent resulted from sticking, joint failure, and distortion.

Other errors rarely addressed include mistakes created intentionally by potters engaging in experimental or inventive activities. Norman Barka and Chris Sheridan (1977, 31-32) noted one potter's attempts to achieve a white slip on a stoneware fabric at the eighteenth-century pottery in Yorktown, Virginia. Whether such experimental attempts were imitative, inventive, or ultimately successful must be established through chronological studies of pottery-specific waster debris, together with regional, national, and international comparative studies of similar techniques. At present, research at this level has not been attempted, presumably because of the complexities involved. Likewise, little attention has been devoted to kiln and ware maintenance techniques. Occasionally, archaeologists observe evidence of kiln repair (Mayes, 1969, 64; Tait and Cherry 1978, 8), but substantive studies of common kiln failures and regular maintenance procedures have yet to be undertaken.

Along a somewhat similar vein, Stanley South (1968) prepared a brief article on ceramic vessel repairs observed for eighteenth-century wares. He reported examples of riveting and glueing, and noted that one potter, Gottfried Aust, had conducted experiments using glazes for mend-

ing. South questioned the extent of these maintenance practices and wondered if other potters also engaged in ware repair to any substantial extent. This was a relatively unique inquiry, and one which might profitably be addressed through examinations of pottery-specific waster debris.

Tool and Machinery Usage

David Newlands (1977a) noted the use of sprig moulds for two Ontario potteries, and his work suggests that a variety of tools would have been available to potters (turning wheels, ribs, brushes, trailing tubes, etc.). Francis Celoria (1973) documented the variety of specialized machinery employed in nineteenth-century English potteries, and David Newlands (1979a) illustrated a few machines found in Ontario potteries. Historical studies can provide extensive knowledge of specialized tools and machines, as can contemporary descriptive accounts (Binns 1897, 1910; Bourry 1897; Brears 1971; Brongniart 1844; Copeland 1972, 1980, 21-32; Shaw 1837). Must archaeological research, however, rely on the discovery of surviving examples? Not entirely. Inferences of tool types can be suggested on the basis of material studies, with technical attributes noted on surviving wares. For example, turning striations on wares indicate the use of a wheel, scoring may suggest the use of ribs, trimming can indicate the use of a cutting edge or wire, brush marks indicate fiber applicators, etc. Perhaps one relatively simple objective which might be adopted for organizing observations of such attributes at a kiln site would be the induction of a tool list for all observable tool marks.

Replicative Experimentation

Because of the wealth of information available on the history of ceramic production, it is often assumed that nothing significant is to be learned beyond that which has already been published. Archaeological remains are regarded as evidence for specific individual events, but often such information is viewed as relatively insignificant for defining past techniques. Many archaeologists, however, strongly disagree with such views. Attempts to re-create historic wares or techniques have repeatedly demonstrated that historic knowledge is often incomplete and inaccurate, while modern techniques and materials are totally inappropriate. In light of this situation, a few researchers have suggested that historical and archaeological inferences of past behaviour must be tested and evaluated by methods which realistically address all technical factors affecting production outputs. The most appropriate method currently employed appears to be replicative experimentation.

Replication of historic events and techniques is not a new phenomena, and the application of such efforts for the evaluation of historical assumptions has been prominent

for at least a century. John Coles (1973, 1979) has summarized many of these efforts. In his discussion of ceramic replication research, previous attention has been focused upon prehistoric and medieval production behaviour (Coles 1979, 183-92). For post-medieval studies, replicative experimentation has received only limited attention in published works. Comments regarding prehistoric and medieval experimentation definitely apply to later periods as well: "Although a considerable number of experimental kilns for firing pots have been constructed, there has been a surprising absence of uniformity in the work, and many basic procedures have been repeated because of the lack of detail provided in some publications" (Coles 1979, 184). To this observation I would add that there have been far too few results of experimentation published, and even those acknowledged in print are so cryptic as to be almost meaningless. Philip Mayes (1969, 69) reported that experimental firings were conducted to evaluate production stages inferred for the seventeenth-century kilns at Northamptonshire. A few conclusions were drawn regarding the time required to load, fire, and unload the kiln, but more substantive results on the effects of firings upon ware production were unpublished.

The most extensive replicative research yet undertaken on pottery production has occurred at Old Sturbridge Village in Massachusetts. John Worrell (1980, 1982) reported on the historical and archaeological research undertaken on the early nineteenth-century pottery of Hervey Brooks in Goshen, Connecticut. Results of this research were used to re-create a workshop and kiln, and historical inferences have been continually evaluated and revised. At least eleven firings have been completed and research is now beginning to focus upon kiln maintenance and repair behaviour. One of the major benefits of this approach to research is that the public can observe historical knowledge as a living display.

Conclusions

Since the mid-1960s, archaeological investigations of Canadian potteries have been initiated at no fewer than twenty sites. From these investigations a body of particularistic historical knowledge has been developed for specific potteries and regions. One expressed objective of this research has been the documentation of techniques of ceramic production. At present, knowledge of past techniques derived from archaeological research remains unstructured, resulting in the identification of sporadic inferences of isolated production steps rather than the induction of relatively complete production sequences.

Using David Newlands's (1979a, 4-21) generalized account of a typical nineteenth-century Ontario procurement and manufacturing sequence for the production of common wares, a hypothetical ceramic production structure has been developed (figs. 3-6). It is hoped that this

model will serve as an impetus for the creation of more elaborate models, for both individual potteries and entire regions engaged in the production of similar wares.

The primary purpose of this discussion has been to focus attention on one research objective readily achievable through the application of an archaeological approach to the historic study of Canadian potteries, that is, the behavioural study of ceramic technology, emphasizing ceramic production techniques, material inputs, and outputs. Summarizing previous Canadian research for the non-archaeologist has demonstrated, I hope, archaeological knowledge at present available for historical research, while the selection of examples of foreign research for Canadian archaeologists has provided thoughts for future discussion and investigation. This effort, however, will be meaningless unless careful attention is given by responsible heritage agencies for preservation, research, development, and public interpretation.

Pottery sites are continually being destroyed, and the scholarly community must call for responsible action. Information on the importance of specific sites must be brought forth in general and scholarly publications. Similarly, previous research at destroyed sites must be published to demonstrate the significance of and scholarly concern for surviving remains. Museum exhibits stressing local, regional, and national heritage are also required to demonstrate concern for Canadian industrial remains. Since exhibits are limited in their temporal presence, however, complementary efforts must also be placed upon the generation of relatively durable public and scholarly exhibit publications. Finally, ceramic industrial history should be brought to life in films, craft demonstrations, and living history displays. Where in Canada can the public see eighteenth- or nineteenth-century ceramics being manufactured? If such an industry could be re-enacted, could it also produce marketable replicated products? If so, could scholarly, interpretive, and economic objectives successfully be intertwined? Personally, as a technical researcher, I would like to think so.

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