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Isaac Tyson, Jr.: Pioneer Industrialist

In an era when American specialists in mining, metallurgy, and industrial chemistry were few, Isaac Tyson, Jr. (1792–1861) was an exceptional practitioner. His blending of science and business was a valuable asset during the pioneer stage of natural resource development in the United States.

The first quarter of the nineteenth century was a period in which the seeds of many future American industries were planted. The War of 1812 gave rise to some of these early industries; internal improvements, better transportation facilities, and a more favorable political and social climate encouraged expansion despite temporary setbacks caused by a flood of importations and the depression of 1819–1821. Among industries that got their first substantial start in this period were the closely related chemical and mining industries. There were a number of related sciences that encouraged and were in turn encouraged by the surge of activity. Among them were assaying (or the chemical analysis of minerals), mineralogy, and geology. More widespread publication of theories, new discoveries, experiments, and practical applications, by scholars, scientists, educators, businessmen, industrialists, and ardent amateurs spread information and aroused curiosity more rapidly than had been the case before the War of 1812, or during colonial times. Science and industry were beginning to march together.

There were many men who took part in this process. Benjamin Silliman, through his work as professor of chemistry and natural history at Yale, his private investigations, and more widely through his *American Journal of Science and Arts*, comes to mind as one of the earliest and most outstanding. But there were others of almost equal stature and many of lesser renown who were involved in converting the theoretical into the practical, the academic studies into the economics of the market place. The academicians observed, reported on, and even investigated in a tentative way the problems encountered in the development of business and industry. They

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moved back and forth between the college halls and the world of business, but most of them stayed on the academic side of the spectrum. The practical men kept in touch with the theorists but concentrated their major efforts on pragmatic trial-and-error methods to solve specific problems in their quest for a livelihood.

Such a man was Isaac Tyson, Jr., of Baltimore. Although he never became famous in the expansive way of later industrial giants, Tyson epitomized the practical men of the first half of the nineteenth century who were searching for ways to apply and profit from the discoveries being made by the mineralogists, the geologists, the chemists, the assayists, and the academicians. Tyson made his fortune by acquiring a virtual monopoly of the economically valuable chromite deposits of Maryland and Pennsylvania. He also did extensive work mining and converting iron, copper, and magnesite, and he dabbled in the production of barite, lead, silver, and other minerals and metals. His work was primarily the manufacture of chemicals, but, in a day when specialists were scarce, he had to be mining engineer, geologist, mineralogist, assayist, metallurgist, banker, business manager, and economist among other things.[1]

Other men were doing these same things at the same time, of course. Tyson was not a great innovator or original thinker. He could not lay claim to any outstanding "firsts" or basic discoveries, but his activities were both so intensive and widespread that his influence pervaded the eastern mining and chemical industries. He put ideas to work. He was insatiably curious and eclectic. He experimented endlessly, applying all the knowledge he could get from books and men to his own enterprises. His career was a mirror of the time when the country and the world were teeming with intellectual and industrial ferment.

Isaac Tyson Jr., was born in Baltimore Jan. 10, 1792, the son of a well-to-do grain merchant. Since his father's name was Jesse the use of "Jr." after the son's name is somewhat puzzling, but it may have been to distinguish him from his grandfather whose name was Isaac. The fact that Isaac, Jr., was a devout Quaker profoundly influenced his life. A quiet, peaceful man who went to great lengths to avoid personal controversy, he constantly questioned the propriety of his inborn acquisitiveness without ever destroying his penchant for making money. Although he could have gone into the grain business with his father, young Isaac became apprenticed to an apothecary to learn the secrets of chemistry. There is a story that at about the age of eighteen he served as supercargo on one of his father's grain vessels, that the ship was wrecked off the coast of France and the crew saved. Isaac is said to have obtained his father's permission to stay in France awhile to study chemistry, geology, and mineralogy. There he gained knowledge of the work of Louis Nicolas Vauquelin, who had discovered chromium in 1797, and became well acquainted with contemporary knowledge of other minerals. Thus, when he returned to America and was shown a piece of black rock discovered by the gardener on Jesse Tyson's estate in the Bare Hills northwest of Baltimore, Isaac recognized it as chromite ($FeCr_2O_4$) – the chief mineral source of chromium. An assay confirmed his opinion and Isaac went into the business of mining and shipping ore to the firm of J. & J. White in Glasgow, Scotland, the major producer of chrome pigments at that time.[2]

In Tyson's day, the metallurgical and refractorial uses of chromium discovered after the Civil War were unknown, but chromium compounds were in demand in the paint, printing, textile, and leather industries. Pigments such as chrome green (Cr_2O_3) and chrome yellow ($PbCrO_4$) were widely used in paints, inks, and dyes. Potassium dichromate ($K_2Cr_2O_7$) and sodium dichromate ($Na_2Cr_2O_7$) were salts used as mordants in textile production – substances which, when combined with a dyestuff, formed insoluable compounds and produced a "fixed" color in fibers. Chrome reagents, in the form of basic chromic sulfates, were produced from the dichromates for use in the "chrome tanning" of shoe uppers and glove kid. Chromic acid (H_2CrO_4), from which the various chromates were made, was also analogous in composition and use to sulfuric acid (H_2SO_4).

Tyson's Bare Hills discovery did not immediately create a boom. There was some local mining of chromite and small production of chrome yellow in Baltimore and Philadelphia and Tyson was apparently involved in these developments.[3] In 1816 he went into

[1] Much of the basic source material in this study is taken from three original documents: Journal of Isaac Tyson, Jr., May 6, 1833–July 7, 1834 (Vermont Historical Society, Montpelier, Vt.); Memorandum Book, kept by Tyson between 1835 and 1850, and now in the possession of his great granddaughter, Miss Rosa Tyson, of South Strafford, Vt.; and Isaac Tyson's Record Book, covering the years 1828–1849 (Maryland Historical Society, Baltimore). The Record Book is the only one with adequate pagination. Citations for the Journal are by date of entries. References to the Memorandum Book cannot be either by page or entry because of the confusion of dates and inadequate pagination. Many of the conclusions arrived at and events described are based on these three sources, or on these sources and original documents which relate to the people and period under discussion.

[2] J. W. Stickney, "Isaac Tyson, Jr., in Vermont," *Report of the State Board of Agriculture Manufactures and Mining, 1875–76* (Montpelier, 1876), 655–56; Horace H. Hayden, "Description of the Bare Hills Near Baltimore," *American Journal of Science and Arts (AJSA)*, XXIV (July, 1833), 349; Mutual Chemical Company of America, *Chromium Chemicals* (*c.* 1941), 12; Williams Haynes, *American Chemical Industry: Background and Beginnings* (New York, 1954), I, 200, 201, VI, 287.

[3] Nancy C. Pearre and Allen V. Heyl, *The History of Chromite Mining in Pennsylvania and Maryland*, Pennsylvania Geological Survey Information Circular 14 (Harrisburg, 1959), 6, 7, 8.

partnership with Howard Sims on Pratt Street in Baltimore to manufacture chemicals, paints, and medicines. About 1822 there was an increased demand in Europe for chromite when chromates were introduced for dyeing. In this year Tyson and Sims incorporated and moved to Washington Street.[4] During this period Tyson's interests expanded to encompass the making of Epsom salts ($MgSO_4.7H_2O$) from magnesite ($MgCO_3$) found with the chromite of the serpentine rocks. Besides their cathartic uses, Epsom salts were in demand as mordants.

The big break in Tyson's career occurred in 1827, a year in which a number of significant events took place. In that year, Howard Sims was an incorporator with David T. McKim and Richard McKim of the Maryland Chymical Co., which became a competitor of Tyson's. Between them, the two firms supplied the American domestic market for Epsom salts.[5] Meanwhile, Tyson went into partnership with Andrew Ellicott in the Baltimore Chemical Manufacturing Co., which dealt in chrome ores and chrome pigments, alum, copperas, Epsom salts, calomel, sulphate of quinine, prussiate of potash, and oil of vitriol. The primary chrome ore was, of course, chromite. Apparently, the chrome pigments included chrome yellow and possibly some chrome green.[6] The alum was probably chrome alum [$KCr(SO_4)_2.12H_2O$], which was used in tanning and as a textile mordant, and common alum [either $KAl(SO_4)_2.12H_2O$ or $NH_4Al(SO_4)_2.12H_2O$ – potash alum and ammonia alum, respectively], which was used as an emetic and as an astringent and stypic. Calomel, or mercurous chloride (Hg_2Cl_2), was, of course, the most popular cathartic of the day, and sulfate of quinine a widely used nonspecific remedy for fever and pain as well as the specific treatment for malaria. Oil of vitriol was merely a colloquial name for sulfuric acid (H_2SO_4). The product of more than passing interest was copperas, which will be discussed in a moment.

Tyson also made his most important discovery of chromite in 1827. This event occurred one day in Bel Air market in Baltimore where he saw barrels in a farmer's cart chocked by large black stones. Tyson learned their source and soon purchased the location, the Reed farm near Jarretsville in Harford County, Maryland.

[4] Thomas W. Griffith, *Annals of Baltimore* (Baltimore, 1824), 228; Pearre and Heyl, *op. cit.*, 7.

[5] *Laws of Maryland, 1826*, Chapter 195; Joseph G. Blandi, "Maryland Business Corporations," *Johns Hopkins University Studies in Historical and Political Science* (Baltimore, 1934), 97; *Journal of the Franklin Institute*, IV, 407; Persifor Frazer, Jr., "The Geology of Lancaster County," *Pennsylvania Second Geological Survey Report C3* (1880), 178; George W. Carpenter, "On the Mineralogy of Chester County," *AJSA*, XIV (1828), 10.

[6] *Dictionary of American Biography*, XVI, 99–100; *The American Advertising Directory for Manufacturers and Dealers in American Goods for the Year 1831* (New York, 1831), 8.

Tyson's snowballing interest and involvement in mining chromite followed this fortuitous event. From that time on, he explored, investigated, and bought up both land and mineral rights to chromite deposits from the Soldiers Delight area west of Baltimore northeastward over a sixty-mile stretch that took him into Lancaster and Chester counties in Pennsylvania. For the next twenty years he dominated the world chromite business until the Turkish deposits were discovered by Dr. J. Lawrence Smith.[7]

Another event in 1827 brought Tyson into a large enterprise which opened a new phase of his multifarious career. The incident involved the patenting of a new process for making copperas.[8]

Copperas, in Tyson's lifetime, was a collective term applied to the sulfates of copper (blue vitriol, $CuSO_4.5H_2O$), iron (green vitriol, $FeSO_4.7H_2O$), and zinc (white vitriol, $ZnSO_4.7H_2O$). Today, "copperas" refers only to ferrous (iron) sulfate – despite its orthographic root. Blue vitriol was used in dyeing and as a disinfectant; green vitriol as a mordant, medicinally, and in the manufacture of ink and pigments; white vitriol in dyes, varnishes, and medicines.

The major domestic sources of copperas were chalcopyrite ($CuFeS_2$), or copper pyrites (the commonest of copper ores), and pyrrhotite ($FE_{1-n}S$), native iron sulfide as extracted by a mine in South Strafford, Vermont. Operated by the Vermont Mineral Factory Co., the mine was the brainchild of a group of Boston money-men led by Colonel Amos Binney and his son, Dr. Amos Binney, an amateur scientist who became an authority on conchology and promoted and patronized scientific investigations while carrying on the family activities in mining, land speculation, iron making, banking, insurance, and industrial development. Tyson obtained some of his copperas from the Vermont Mineral Factory Co., which, in 1827, under young Doctor Binney's guidance, was preparing to exploit the increasing copper content of its ores by establishing what was to be the first large-scale mineside copper smelting plant in this country.[9]

About this time also, Tyson, in addition to his interest in copperas and its manufacture, was investing in copper mines in Frederick County, Maryland, with Evan T. Ellicott of Baltimore.[10] Just what they accomplished is not clear, but a significant event occurred in

[7] William Glenn, "Chrome in the Southern Appalachian Region," *Transactions of the American Institute of Mining Engineers*, XXV (1895), 481–99; *idem.*, "Chrome," *Maryland, Its Resources, Industries, and Institutions* (Baltimore, 1893), 120–22.

[8] *Digest of Patents Issued by the United States from 1790 to Jan. 1, 1839* (Washington, 1840), 138; *Journal of the Franklin Institute*, IV (1827), 142.

[9] See Collamer M. Abbott, "Early Copper Smelting in Vermont," *Vermont History*, XXXIII (Jan., 1965), 233–42.

[10] Isaac Tyson, Jr., Record Book, 172–76.

1827 when a German metallurgist named Tillman, who had been imported to operate a copper furnace at the Bridgewater mine in New Jersey, was lent to Isaac Tyson for assistance at the Liberty mine.[11] The facts are meager, but given Tyson's inquisitive nature, whatever the results of his early work at the Liberty mine, we can be sure that he gleaned all the information Tillman had about smelting copper ores. An earlier incident had already tied Tyson and Ellicott to the members of the group which launched the highly speculative venture of mining and smelting copper ores in the wilderness of Vermont. In 1824 chalcopyrite was discovered in Grafton County, New Hampshire, bordering Orange County, Vermont, where the South Strafford mine was located. In 1825 some of this ore was shipped to Baltimore and smelted in an iron furnace operated by the Ellicotts. The result, a thirty-two pound chunk of copper, was displayed in the office of the Merchants' Insurance Co. in Boston. Two of the directors of this company were Colonel Amos Binney and John Bumstead, who were backers of the South Strafford copperas-copper mine. The Ellicotts, in addition to being business associates of Isaac Tyson, were related to him by marriage.[12]

By 1830, Tyson was interesting himself in the copper deposits of Vermont. He bought individually, and in association with Dr. Amos Binney, land and mineral rights in Strafford and neighboring Vershire, where copper had been discovered and worked by local farmers.[13] Smelting at South Strafford got under way in 1831 under the direction of Daniel Long, a native of Harford, Maryland, who had been sent up from Baltimore. In 1833, additional funds were invested in the copper end of the business and Tyson agreed to go to Vermont to superintend both the copperas and copper plants.

Tyson stayed in Vermont for fifteen months. During that time he gave full play to his penchant for experimentation. He learned to make Venetian red pigments (probably by treating green vitriol with lime) and to distill sulfuric acid and to melt sulfur out of the sulfates. Out of these Vermont days also came a patent for applying heated air to the smelting of copper ores and the testing of anthracite coal almost simultaneously with the issuance of a patent to Frederick Geissenhainer of New York City for the use of anthracite to smelt iron. Tyson's use of a hot blast and anthracite to smelt

[11] G. W. Stokes, *Notes on Copper in New Jersey* (n.p., 1890), 3.

[12] James F. Dana, "Mineral Locations," *AJSA* (1824), 234; *idem.*, "Analysis of the Copper Ore of Franconia, New Hampshire," *Annals of the Lyceum of Natural History of New York*, II (1828), 253–58; *Niles Weekly Register*, XXIX (Oct. 22, 1825), 115; *Massachusetts Special Laws, 1814–1822*, V (1821), Chapter 105, p. 497; James W. Tyson, II, letter to the author, Nov. 9, 1965.

[13] Strafford, Vt., Land Records, Book VII, 502; Vershire, Vt., Land Records, Book XI, 141, 146, 148, 170, 286, 288, 299.

copper may have been the first such use. His stove for heating the blast resembled that of James B. Neilson, the Scot who had first used a heated blast on iron in 1828. Although Tyson did make his invention work, the process was not highly successful at South Strafford. Partly because of insurmountable technical and transportation difficulties, but also because of the national financial stringency of 1833–1834, Tyson abandoned superintendence of the South Strafford enterprise in August 1834. His Memorandum Book noted that his experiment was a failure, but to conclude that Tyson's efforts were a total failure would be erroneous. Like many of the later and more famous entrepreneurs, industrialists, and merchant princes of the nineteenth century, Tyson took his "failures" as merely minor steps along the road to success.[14]

Here a brief related digression is necessary to insert another link in the story – a link which tied Tyson's own interests to those of the Vermont Mineral Factory Co. and the whole chemical industry.[15] The flooding of the American market with English goods after the War of 1812 and the financial panic of 1819 had had adverse effects on the war-born Vermont copperas industry. As early as 1812 Colonel Amos Binney had sought through Congressman Josiah Quincy of Massachusetts to get a tariff placed on imported copperas.[16] Not until the 1816 tariff bill, however, was a tax of $1.00 a hundredweight levied. This did not entirely solve the problem and the industry struggled along until the tax was increased to $2.00 a hundredweight in 1824.[17] This and technical improvements, possibly including Tyson's process for making copperas, put the industry on its feet and enabled the South Strafford company profitably to dominate the American copperas market.[18] Indirectly, the tariff, by enabling the copperas business to prosper, made it possible to attempt exploitation of the copper in the ores and establish the smelting plant in Vermont.

In the campaign for tariffs, Isaac Tyson played a leading role as chairman of the Committee on Chemistry of the General Convention of the Friends of Domestic Industry. His own ability to compete

[14] C. M. Abbott, *op. cit.*; Tyson, Journal, *passim*; Tyson, Memorandum Book.

[15] Amos Binney, letters in *Documents Relative to the Manufactures of the United States, Collected and Transmitted to the House of Representatives by the Secretary of the Treasury in Compliance with a Resolution of Jan. 19, 1832*, 22d Cong., 1st Sess., House Doc. 308 (1833), I, 894, 895, 906, 907; Isaac Tyson, Jr., "Report of the Committee on Chemistry of the General Convention of the Friends of Domestic Industry," Read Oct. 26, 1831, in New York City, reprinted in *Journal of Industrial and Engineering Chemistry*, IX (1917), 177–81.

[16] *Journal of the House of Representatives of the United States, at the First Session of the 12th Congress, begun Nov. 4, 1811*, VIII, 164.

[17] J. Leander Bishop, *A History of American Manufactures from 1608–1860* (3rd ed., 3 vols., Philadelphia, 1868), II, 228, 292.

[18] Amos Binney, letters, *op. cit.*

with foreign competition in every phase of his expanding business depended on the tariff. His report, read October 26, 1831, before a meeting of the committee in New York City, summarized the effect of the tariff on the small but growing chemical and mining industries, in which he was so intimately involved. Like his fellow industrialists, Tyson was convinced that an adequate tariff would save the industries and make it possible for the United States to compete in world markets as well as to supply its own needs. With this conviction Tyson worked in cooperation with his fellow industrialists to bring about the desired result. His report summarized the effect of the War of 1812 and its aftermath and the beneficial influence of the tariff on the chemical industry, which was closely tied to mining and metallurgy.

To return to Tyson's "failure" at South Strafford. With Tyson one project led to another. He kept moving ahead despite temporary setbacks. His "failure" at South Strafford occurred simultaneously with his successful pursuit of chromite in Maryland and Pennsylvania. So well known was he already that prospectors from far and wide brought or sent ore samples to his laboratory for analysis on the chance that Tyson might be interested in investing. In this way and through his employees, whom he sent on exploring expeditions, Tyson learned of new mineral deposits from Maine to Virginia and from Missouri to Cuba. Some of these were will-o'-the-wisps, others proved too distant or too uncertain for Tyson to undertake.[19]

One mineral deposit, however, discovered while Tyson was at South Strafford, was the basis for a profitable iron mining and smelting establishment. After his stay at South Strafford Tyson returned to his home base in Baltimore, but through his lieutenants he began development of iron deposits at what became known as Tyson Furnace in the town of Plymouth, about forty miles from South Strafford. In 1837, after two years of preparation, Tyson blew in his furnace using the hot blast system he had devised at South Strafford. By this time others were experimenting with hot blast systems and with anthracite. At Plymouth, Tyson used charcoal because shipment of anthracite coal in quantity to Vermont was not economically feasible. Purchase of extensive woodlots solved the fuel problem for his iron furnace which produced actively for the next twenty years. The efficacy of Tyson's hot blast system was recognized by the eminent geologist Dr. Charles T. Jackson, who recommended its use to other ironmasters.[20]

[19] Tyson Journal, Memorandum Book, and Record Book, *passim*.
[20] J. W. Stickney, *op. cit.*; *Report on the Tyson Iron Company* (Boston, 1864); Charles T. Jackson, *Final Report on the Geology and Mineralogy of the State of New Hampshire* (Concord, 1844), 204.

Undertaking the mining and smelting of iron in remote Plymouth and the copper venture in equally remote Strafford now seem like unreasonably risky ventures, but they were typical examples of Tyson's tireless search for all kinds of minerals. For him all of his various pursuits were intimately related. Take anthracite coal, for instance. Once he adopted the idea of using it for smelting (an idea not original with him),[21] Tyson never stopped looking. For a time, while at South Strafford, he was interested in attempts to work what was supposed to be a bed of anthracite coal in Bath, New Hampshire, about forty miles northeast of Strafford. He checked other rumors of what proved to be non-existent anthracite deposits in his search for better fuels.[22] Lead, to take another example, was necessary in the production of chrome yellow and for the large vats used in making different chemicals. This need prompted Tyson to invest with Amos Binney in the Eaton, New Hampshire, lead mine and to investigate lead deposits in Thetford, Vermont; Rossie, New York; Shelburne, New Hampshire; Virginia and Missouri; and to consider seriously importation of lead ore from Spain for smelting at Baltimore.[23] Tyson sought barite ($BaSO_4$) in Pennsylvania, which could be used as body or filler in certain kinds of paper and as a white paint pigment, and with which he experimented in making chrome yellow; chromite and copper in Cuba; and iron in Vermont, New York, Maryland, and Virginia. He also imported chromite for testing from Russia, Norway, and the Shetland Islands. This incessant search for every kind of mineral was a facet of Tyson's penchant for experimentation and his pioneer attempts to utilize all the values in every ore. The latter trait was demonstrated in his efforts to make copperas and copper and utilize the residues from the operations in producing Venetian red, sulfur, sulfuric acid, copper sulfate, and iron at South Strafford.[24]

Simultaneously with his extensive development of the chromite deposits of Maryland and Pennsylvania and the iron mine in Plymouth in the 1830's, Tyson began more intensive development and

[21] *Prospectus of the Canton Company of Baltimore to which is Prefixed a Map of the Company's Ground; together with the Act of Incorporation and an Explanation of the Designs of the Company and Some views of the Local Advantages of Baltimore* (Baltimore, 1829), 25, 26; James M. Swank, "History of Iron in the United States," *Report on the Manufactures of the United States at the Tenth Census, June 1, 1880* (Washington, 1883), II, 113–16; Walter R. Johnson, *Notes on the Use of Anthracite in the Manufacture of Iron* (Boston, 1841), 12, 13, 15, 20, 24, 32, 33, 34, 36.
[22] Tyson Journal, entries of Aug. 11 and 25, Jan. 13, 1834; Tyson Memorandum Book, *passim*.
[23] Tyson Memorandum Book, *passim*; Tyson Journal, entries of Oct. 22, Nov. 19, 1833; April 7, 9, 11, 16, July 6, 1834; Anon., "Baltimore," *North American Review*, XX (1825), 130.
[24] Tyson Memorandum Book and Journal, *passim*.

exploitation of the copper deposits of Maryland. He maintained his financial interest but was not active in the development of the Vermont deposits after 1834. Further development of Vermont's copper mines was left to others, including his son James who resumed work at South Strafford in the final quarter of the century. After his departure from South Strafford, where the first era of smelting ended in the wake of the panic of 1837, Isaac Tyson became the driving force in the effort to exploit Maryland's copper deposits in the 1830's, 1840's, and 1850's. About 1837 he opened the New London mine in Frederick County. The next year, with Evan T. Ellicott, he began attempts to smelt the ore of the Liberty mine, which had been previously used only for the manufacture of copper sulfate in Baltimore. Then followed, in the 1840's, development of the Dolly Hyde mine in Frederick County, the Springfield, Mineral Hill, and Patapsco mines in Carroll County, and the Bare Hills mine in Baltimore County. Ultimately, Tyson either owned or leased with other Maryland money-men, the most economically important copper mines in Maryland. And once more Tyson could not resist joining the processing with the mining of the ores, as shown in his attempts to smelt at the Liberty mine and later the Springfield ores at Elba furnace near Sykesville.[25]

The rising demand and interest in domestic supplies of copper which had begun in the 1820's and increased through the 1830's and early 1840's – a process spearheaded by Tyson and his Baltimore colleagues and the Binneys and their Boston associates – led to the establishment of the first custom smelting plants at Point Shirley near Boston in 1844 and on Locust Point in Baltimore in 1845.[26] Tyson does not seem to have been directly connected with the first copper smelting plant in Baltimore erected by the Baltimore and Cuba Smelting and Mining Co., but he undoubtedly sent some of his ores there – probably from the Dolly Hyde, the Springfield, and Bare Hills mines. Tyson, however, was an incorporator of the smelting plant established by the Baltimore Copper Smelting Co. in 1850 with the assistance of David Keener, who resigned from the earlier

[25] Tyson's work in the copper mines of Maryland has been described in a number of articles, including the following: R. Brent Keyser, "Copper," *Maryland, Its Resources, Industries and Institutions*, *op. cit.*, 112–16; Ralph J. Robinson, "Maryland's 200-Year-Old Copper Industry," *Baltimore* (July, 1939), 23–30; Nancy C. Pearre, "Mining for Copper and Related Minerals in Maryland," *Maryland Historical Magazine*, LIX (March, 1964), 15–33. The Tyson Memorandum Book, Journal, and Record Book also reveal many facts about Tyson's copper mining enterprises.

[26] Thomas Egleston, "The Point Shirley Copper Works," *The School of Mines Quarterly*, VII (1886), 360–84; R. Brent Keyser, *op. cit.*, 115–17; "The Baltimore Copper Works," *Engineering and Mining Journal (EMJ)*, XXXII (Aug. 6, 1881), 87; Alfred B. Lindley, "The Copper Tariff of 1869," *Michigan History*, XXXV (March, 1951), 1–30; James Douglas, "Historical Sketch of Copper Smelting in the United States," *The Mineral Industry, Its Statistics, Technology and Trade to the End of 1895* (New York, 1896), IV, 269–86.

company to lend his skill to the new company. This firm (later consolidated with the Baltimore and Cuba) set up its plant in the Canton section of Baltimore where the present-day refining industry is located.[27]

Tyson's great contribution to the pioneer chemical industry was his solution to the problem of commercial production of potassium bichromate. Published accounts point out that Tyson tried unsuccessfully to produce chrome pigments and salts in 1828 and 1833 before finally succeeding in 1845.[28] However, it seems clear that Tyson produced chrome yellow and green as early as 1831 and possibly before that.[29] During the 1830's he was testing ores from different sources for chrome yellow. Success in producing potassium bichromate is attributed to the work of Richard A. Tighlman, an 1841 graduate of the University of Pennsylvania, whose first practical work was concerned with a method of manufacturing potassium bichromate which was adopted by Tyson's Baltimore chrome factory. Tyson's Memo Book shows that Tyson himself first produced potassium bichromate in April 1843 in his laboratory and continued his experiments with different ores throughout that year. In early 1844, Tighlman began working on the experiments that finally led to commercial manufacture of the compound, possibly as early as 1845, and certainly by 1846 as is shown by a letter written by one of Tyson's employes.[30]

Tyson is said to have hired in 1846 William P. Blake, then a Yale student and later a prominent economic geologist, to work in his laboratory. This was reportedly the first instance of a college-trained chemist being employed in industry,[31] but an entry in Tyson's Memo Book, February 25, 1850, which reads: "Wm. P. Blake begins at Laboratory," casts doubt on this assertion.[32] Tyson's first college-trained assistant was probably James B. Rogers, a medical doctor educated at the University of Maryland and the eldest of the famous four Rogers brothers who became widely known in the 1830's for their geological surveys of Virginia, Pennsylvania, and New Jersey. James B. Rogers worked in Tyson's laboratory in the

[27] James Douglas, *loc. cit.*; *Laws of Maryland 1849*, Chapter 158.

[28] Mutual Chemical Company of America, *op. cit.*, 16; Pearre and Heyl, *op. cit.*, 9; D. T. Day, "Chromium," *Mineral Resources of the United States, 1883–1884* (Washington, 1885), 567.

[29] Anon., "Baltimore," *North American Review*, *loc. cit.*; William Glenn, *op. cit.*, 120; Parker Cleaveland, *An Elementary Treatise on Mineralogy and Geology* (Boston, 1822), II, 624; Isaac Tyson, Jr., "Report of the Committee on Chemistry . . . ," *op. cit.*; *The American Advertising Directory for Manufacturers and Dealers in American Goods for the Year 1831*, *op. cit.*, 8.

[30] *Dictionary of American Biography*, XVIII, 544; Memorandum Book, no page, entries for 1843, 1844, 1845; Jesse Tyson to James W. Tyson, Oct. 22, 1846.

[31] William Glenn, "Chrome," *op. cit.*, 122.

[32] Memorandum Book, no page, entry dated Feb. 25, 1850.

summers of 1826 and 1827 and in 1828 was in charge of the establishment.[33] Of minor interest in showing Tyson's ability to attract qualified assistants was the stimulating presence in 1828 of a French student and friend of Louis Jacques Thenard, the man who collaborated with Gay-Lussac in studies of several chemicals including potassium.[34] We may recall, too, that the period 1827–1829 was the time when Tyson was benefiting from the metallurgical knowledge of the German, Tillman. At least one other college-trained man worked with Tyson. He was another German, Otto Dieffenbach, who was at Tyson's laboratory in the early 1850's.[35]

Throughout his career Tyson was in frequent touch with well-known experts in different fields. Dr. C. G. Hussey, who is given credit for establishing in 1847 the first furnace in Pittsburgh to refine Michigan's native copper, asked Tyson in 1843 to assay a sample of copper ore from Missouri. Among Tyson's acquaintances were Dr. Charles T. Jackson of Boston, notorious for his controversies over the discovery of anesthesia and wireless telegraphy, but much more prolific in producing state geological surveys and conducting investigations of mineral deposits from Nova Scotia to Alabama; James T. Hodge, geologist and chemist who did early work in the East as well as in Michigan; Oliver P. Hubbard, professor of chemistry at Dartmouth College; Dr. Frederick Hall, professor of chemistry and natural philosophy and president of Mount Hope College in Maryland; Julius T. Ducatel, Maryland state geologist; Frederick C. Kropff, German immigrant chemist who settled in Philadelphia; Thomas P. Jones, an official of the Franklin Institute, examiner for and later superintendent of the United States Patent Office and editor of the *Journal of the Franklin Institute*; Isaac McKim, prominent Baltimore merchant, copper manufacturer, and member of Congress; Cyrus Alger, the Boston iron founder and inventer; and others.[36]

While he was dealing with the more widely known men of science and industry of his day, a not less important sharing of information and techniques was taking place with his more humble employes. A large number of skilled and unskilled workers passed through Tyson's "school" – his chromite mines in Maryland and Pennsylvania, his copper and iron enterprises in Maryland and Vermont,

[33] James B. Rogers to Patrick Kerr Rogers, April 20, 1827; Henry D. Rogers to Patrick Kerr Rogers, June 7, 1828, William B. Rogers to Patrick Kerr Rogers, June 26, 1828, all quoted in Emma Rogers (ed.), *Life and Letters of William Barton Rogers* (Boston, 1896), I, 43, 52; *DAB*, XVI, 99-100.

[34] William B. Rogers to Patrick Kerr Rogers, June 26, 1828, *op. cit.*

[35] *Pearre and Heyl, op. cit.*, 9.

[36] Memorandum Book and Journal, *passim.*

laboratories and factories in Baltimore. A few examples will e the process. As already mentioned, before Tyson took over th Strafford, Vermont, Daniel Long was sent up from Balti- oversee the first attempts to smelt the copper ore in 1831, wo years before Tyson arrived. From the evidence it seems le that Daniel Long had some relationship with attempts by or his associates to smelt copper (and possibly iron) in nd. After Tyson came to South Strafford he worked closely ong who remained in direct charge of the smelting operation. Long stayed on at South Strafford through 1839, but did xploring and purchasing of mineral rights for Tyson in other nt localities. Then in 1840, Long went to Tyson's iron furnace outh. Subsequently, in 1844, Long migrated to Point Shirley oston, where the Revere Copper Company was establishing t large-scale custom copper smelting plant in this country.[37] matter of curiosity, Tyson's influence extended even further. 65, men from the Revere copper works designed and helped set last furnaces for smelting copper at the Hartford mine in ec. And in 1867, a son of Daniel, William H. Long, who had d copper smelting at the Revere works, designed and superin- ded the blast furnaces for copper smelting at the Ely mine in shire, where Tyson had done some work in the 1830's. Subse- ly, three other sons of Daniel Long, all trained at the Revere s, had roles in making the Ely mine a successful enterprise during its heyday in the 1870's.[38]

Daniel Long personified only one example of how men trained under Tyson had opportunity to spread techniques and ideas that were relatively new to this country and not widely used or tested until the expansion of the West drew upon every available source of mining and metallurgical information. Other individuals who learned in Tyson's school and spread the word included William Chynoweth, a key man at South Strafford, who explored other deposits and bought mineral rights for Tyson in New Hampshire and Vermont, was an associate with Tyson and other Maryland men in incorporation of the Liberty Copper Company, and later went to North Carolina; Joseph Martin, who worked at South Strafford and Plymouth for Tyson; Jacob Fox, who explored for copper at Waterbury, Vermont, as well as in Cuba, and also worked in Tyson's

[37] *United Opinion* (Bradford, Vt.), March 4, 1892, and Aug. 10, 1895; *Argus and Patriot* (Montpelier, Vt.), Aug. 27, 1890, and Nov. 15, 1893; Death records in Office of Secretary of State, Montpelier, Vt.

[38] W. H. Adams, "Copper Smelting in 1865," *EMJ*, XLII (Dec. 4, 1886), 401; *Argus and Patriot*, Nov. 15, 1893; *United Opinion*, Aug. 10, 1895; Vermont Historical Society, *Proceedings, 1916-17* (Montpelier, 1918), 150.

Maryland copper mines; William Gundry, another key man at South Strafford, who turned up in Virginia in 1849 as a foreman at the Amherst Copper Mining and Smelting Co., and later went to Ohio. The number of ordinary miners who worked for Tyson is unknown, but they represented an important segment of the contemporary mining industry in Vermont, Pennsylvania, Maryland, Cuba, and Virginia.[39]

Tyson's business associations spanned two continents. His dealings involved shipments of chromite to England and France through the mercantile banking houses of Cropper, Benson & Co. in Liverpool and Alexander Brown & Sons in Baltimore and its branches in New York, Philadelphia, and London. Tyson also dealt with French companies in Paris through their representatives in New York City. Financing of various enterprises and of shipments of his products involved banks in this country and England, from small rural banks like the Bank of Orange County in Chelsea, Vermont, to the Suffolk Bank of Boston and the larger institutions of Philadelphia, Baltimore and New York. Many of Tyson's undertakings were so unusual and out-of-the-way that their execution required a constant do-it-yourself resourcefulness. Such was his detailed (but unsuccessful) negotiation with canal lock proprietors along the Connecticut River from Hartford, Vermont, to Hartford, Connecticut, for more favorable rates for shipping copper and copperas to market and obtaining equipment and supplies, including anthracite coal, from outside sources.[40]

Tyson's varied interests necessitated widespread dealings with scores of businessmen throughout the East. Numerous, too, were his relationships with local money-men who invested with him in the development of speculative mining properties in Vermont, Maryland, New Hampshire, Virginia, and Pennsylvania.[41] Of significance in Baltimore, were the prominent names of Patterson, Ellicott, McKim, and Keener, all of whom had connections with large commercial and manufacturing enterprises. Tyson dealt with these men, not only as a buyer and seller of products, but as an associate in corporations such as the Baltimore Copper Smelting Co. and the mining companies formed to develop mineral deposits. Andrew and Evan T. Ellicott, David Keener, and Isaac McKim have been mentioned. The list also includes Christian Keener, William Patterson, Jefferson Ramsay, Richard and William Coale, George Brown, and

[39] Tyson Memorandum Book, Journal, and Record Book, *passim*.
[40] *Ibid.*
[41] *Ibid.*; *Laws of Vermont* (1836), 118; *Ibid.* (1855), 118.

Galloway Cheston.[42] In his Vermont undertakings, Tyson numbered among his associates Boston money-men, such as the two Binneys, William, William B., and John Reynolds, John Bumstead, and John Heard, Jr., all prominent in various businesses such as commerce, banking, insurance, land development, law, and mining. The need for funds and advice also brought Tyson into direct contact with such locally prominent businessmen as Jedediah H. Harris of Strafford, Vermont, a successful merchant and influential citizen with interests in banking and other enterprises who could command considerable amounts of money. This association led to acquaintance with Justin Smith Morrill, Harris' partner and later Vermont's celebrated senator.

So carefully controlled were his interests, that Tyson's investments endured well beyond his death in 1861 under the guidance of his sons James and Jesse, who had been taken into the business and were handed the burden of maintaining it. The Tyson chromite business enjoyed its domestic monopoly until about 1880 and James and Jesse kept the Tyson name active in mining and manufacturing into the twentieth century.[43] Without doubt Isaac Tyson was a wealthy man, but with the records available it is difficult to establish how wealthy. In 1892, Jesse Tyson was listed as a millionaire manufacturer of chemicals.[44] It is possible that Isaac was a millionaire, or close to it, in his lifetime. His will, drawn in 1860, does not reveal the full value of his estate, but the most significant bequest in terms of his industrial heritage was the real estate, including the mines and mineral rights, which was handed down to his executors, the sons James and Jesse, who were to carry on the mining and manufacturing enterprises.[45]

One estimate, made in 1868, of the value of ore extracted from the Wood mine, the most productive chrome deposit in the world at one time, went as high as $9,000,000.[46] A more realistic figure, taking $35 a ton as the average price during the period 1822–1854 and the minimum production figure of 96,000 tons before 1900, would set the value of the ore at slightly over $3,000,000. The Reed mine may

[42] Tyson Memorandum Book, Journal, and Record Book, *passim*; *Laws of Vermont* (1833), 84; *Laws of Maryland* (1836), Chapter 96.
[43] Tyson Memorandum Book, Journal, and Record Book, *passim*; Pearre and Heyl, *op. cit.*, 9–11; Unidentified newspaper clipping dated "Jan'y 1889" in Daniel Cobb Scrapbook No. 2 (Strafford, Vt., Historical Society Collections); *United Opinion*, Dec. 15, 1899; "Elizabeth Mine. Act of Incorporation, etc. To Be Kept in Strafford," MS record book, 1881–1904, in possession of Miss Rosa Tyson, South Strafford, Vt.
[44] Sidney Ratner (ed.), *New Light on the History of Great American Fortunes: American Millionaires of 1892 and 1902* (New York, 1953), 141.
[45] Strafford, Vt., Land Records, Book XVII, 454 457.
[46] *American Journal of Mining*, V (Feb. 8, 1868), 85.

have produced even more, in excess of 100,000 tons.[47] The Red Pit, the Scott, the Line Pit, the Choate were other large producers. In many instances production is unknown. In other cases, production is believed to be much larger than extant figures indicate. Estimates are for production of ore only and do not include the value of manufactured products. Besides the land and mineral rights which Tyson acquired throughout the East, he owned a number of properties, including warehouses, factories, and laboratories on different sites in Baltimore, in other parts of Maryland, and in Pennsylvania and Vermont.

When the Boston Copper Mining Co. was organized in Massachusetts in 1833, the company was given permission to hold real estate not exceeding $100,000 in value and personal estate of $200,000.[48] The investment did not reach that size, but the incorporation indicated the grandiose visions the men had – dreams which, the evidence suggests, contemplated something much larger than the plant that materialized in Vermont – possibly smelting and processing plants in Boston or Baltimore. The Boston Copper Mining Co. was incorporated later in the year in Vermont without mention of limits on personal and real property. In the agreement Tyson made with Amos Binney and the Vermont Mineral Factory Co. for operation of the plant, the parties agreed initially to contribute a total of $25,000.[49] The whole property at South Strafford – copperas and copper plant combined – was valued at $60,000 in 1832 by Amos Binney.[50] During Tyson's stay, the proprietors once voted to borrow an additional $30,000 and on several occasions Tyson obtained sums totaling several thousand dollars in each case, as well as smaller amounts, for operating expenses.[51] As iron mines and furnaces went, even in the 1840's, Tyson's Plymouth, Vermont, establishment was small, but it was valued at $32,375 in 1845.[52] The output is unknown, but from 1837 to 1860 Tyson manufactured castings, holloware, and stoves which were sold all over the East. One report put the number of stoves produced in the 1839–1840 season at 2,000.[53]

The stove business promised so well, in fact, that Tyson attempted to engage the services of the young Strafford merchant, Justin Smith Morrill, as traveling salesman for his products. Morrill, however,

[47] Nancy C. Pearre and Allen Heyl, Jr., *Chromite and Other Mineral Deposits in the Serpentine Rocks of the Piedmont Upland, Maryland, Pennsylvania, and Delaware*, U. S. Geological Survey Bulletin 1082-K (Washington, 1960), 735, 736, 742.
[48] *Massachusetts Special Laws*, VII, Chapter 86, p. 328.
[49] Tyson Memorandum Book, no page.
[50] Amos Binney, letters, *op. cit.*, I, 894.
[51] Tyson Journal, *passim*.
[52] Tyson Record Book, 376, 377.
[53] *Vermont Mercury* (Woodstock, Vt.), Nov. 27, 1840.

decided that the job would not offer enough freedom of action for his independent and ambitious nature. He feared he might be hampered by restrictions set by his employer.[54] As an employe of Isaac Tyson, Morrill might have prospered, but he would have missed the fame he gained as author of federal tariff and land-grant college legislation.

In an era when American specialists in mining, metallurgy, and industrial chemistry were few, Isaac Tyson was, thus, an exceptional practitioner. Before the great mining booms of the 1840's Tyson stood out as a versatile jack-of-all specialties in these fields. The physical extent of his interests, which was spread over a major portion of the eastern United States, was in itself unusual – perhaps unprecedented. In all these respects Tyson foreshadowed the later-day industrial giants and money-men with diversified investments. Tyson's interest was much more detailed – he occupied himself with everything from the correct weight of mining hammers to the cost of transportation by canal – and although this set limitations on his activities and achievements, it was a valuable asset during the 1820's and 1830's when exploitation and development of the country's natural resources were still in the pioneer stage.

[54] Justin Smith Morrill to Isaac Tyson, Jr., July 12, 1839.